TREES + ME=

FORESTRY

18 U.S.C. 707

Adapted for use in Pennsylvania by
Robert S. Hansen, extension forester in Bradford County, and
James C. Finley, assistant professor of forest resources.

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Chapter 1

TREES + ME = FORESTRY
An Introduction to Forest Resources

VISITING A NEW WORLD

Imagine that you're an alien from another planet. You have just landed in the middle of a strange, yet beautiful, place. Giant living plants surround you. The air smells clean and fresh. Welcome to a forest!

A forest is an area of plants and animals made up mostly of trees. Every forest has layers of plants. These main layers are the **canopy,** the **understory,** and the **forest floor.**

The canopy is formed by the branches and leaves from the tallest trees. Beneath the canopy is the understory, where shorter trees and shrubs grow. The forest floor has seedlings, grasses, ferns, and crumbling plants and logs. Different kinds of plants and animals live in different layers of the forest.

Different kinds of plants and animals live in different kinds of forests, too. Why? Because forests have different soils, climates, and amounts of water. For example, a hemlock tree grows best in a wet, moist, cool, forest. A chestnut oak grows better where it is dry and warm.

Forest ecology is the study of how soils, sunlight, water, and other parts of nature work together to make a unique forest.

Any product or benefit that comes from the forest is a **forest resource.**

On page 5 you'll find a crossword puzzle of forest resources.

Fill in the blanks to learn what the forest has to offer!

Forests are important because they:

— feed and shelter wildlife

— protect soil from blowing or washing away

— make the world beautiful

— provide a place for recreation

— help keep rivers and streams clean

— provide timber for wood products

Forests help all of us in many ways.

Each person in the United States uses enough wood products in one year to make up a tree 100 feet tall and 16 inches in diameter!

RESOURCES FOR EVERYONE

Forestry is the study and practice of managing wooded lands. Forestry is a science. It also is a business and an art. Forestry is part of the field of **conservation**—the practice of caring for natural resources. **Foresters** are people who are trained to oversee the woods. They make sure that the forest makes the resources we need. They also make sure we will be able to enjoy these same things in the future.

Forests are **renewable resources**. For example, even though millions of Christmas trees are cut every year, there will be more in the future because they are renewable. If forests are taken care of, they will regrow.

Managing a forest for more than one benefit or product is **multiple resource management**. Foresters take care of forests not just for wood but also for wildlife. They plan for hikers. They make sure the forest stays healthy. They protect the soil and water. Foresters try to find the best balance among all products and benefits.

In Pennsylvania, the wood products industry is a very important user of forest resources. The industry employs thousands of people. These people make billions of dollars worth of wood products each year.

Place an **R** *by the items below that are renewable resources. Plane an* **N** *by the items that are nonrenewable (cannot be replaced once used).*

___ black cherry ___ sunfish

___ natural gas ___ white ash

___ raccoons ___ diamonds

___ garter snakes ___ zinc

___ copper ___ coal

Re-Tree-Ve the resource!

ACROSS

1. This sweet, sticky substance comes from the sap of a sugar maple tree.
2. This involves lunches, fun, and ants.
3. This needs a worm, hook, and lots of luck.
4. These come from maple and like to be "knocked out" when you bowl.
5. Made from the pulp of trees, this can be found "rolling around" in bathrooms.
6. These are made from tree pulp and hold lots of lemonade.

DOWN

1. This requires a tent, cookstove, and lantern.
2. When trees breathe, they make this.
3. These come from white ash trees and turn kids into real sluggers!
4. Made from wood, these help you do your homework.
5. Trees protect this by keeping soil and pollution from entering streams.
6. This requires healthy minds, strong feet, and a walking stick.
7. This comes from logs and is used to build houses.

FORESTS PROVIDE MANY JOBS.

Can you match each drawing with a career?

CAREER CONSIDERATIONS

A forester manages woodlands. A forester looks at all of the things a forest provides—timber, recreation, water, wildlife, and beauty—to make decisions. A forester's goal is to provide many benefits from the forest. To become a forester, you should start by entering a college or university that has a forest resources program.

LEAVE THE ANSWER TO ME

Imagine that you are a chef. You are in charge of writing a recipe for a forest. What ingredients would you include?

TREE-VIAL PURSUIT

Did you know that the forest industry ranks among the top 10 employers in 40 of the 50 states?

YEARNING TO LEARN

Additional Activities

In the following activities, remember the basic rules of conservation. Do not damage or destroy the plants and animals you are studying. Leave all animal homes unchanged. Have a positive impact on the forest.

Take a walk in a park, nature area, forest, or wooded backyard. Look at the trees, plants, and animals and decide in which area each lives—the canopy, understory, or forest floor. Collect an item from each layer. Answer the questions on the next page under "Points to Ponder on Your Nature Walk" after you have completed your nature walk.

QUIZ FOR THE REAL WHIZZES

Fill in the blanks below using the words at the end. Whiz through this!

1. The _____ is the top of the forest and is made up of branches and leaves from the tallest trees.
2. _____ is the study of how soil, sunlight, water, and living things work together, blending to make a unique forest.
3. Proper care of our natural resources is called _____.
4. _____ is a science, a business, and an art that includes conservation and management of forests.
5. Management of the forest for more than one resource is called _____ management.
6. Forests are a _____ because they can regrow and renew themselves.
7. The layer of shorter trees and shrubs directly below the canopy is called the _____.
8. The _____ is the bottom layer in a forest ecosystem, where seedlings, grasses, and wildflowers grow.

renewable resource	forest ecology
forest floor	multiple resource
conservation	understory
forestry	canopy

COUNTY 4-H ROUNDUP REQUIREMENTS

1. The exhibit should not exceed 12 inches deep by 18 inches wide by 22 inches high.
2. Exhibits should include a project title and your name.

TIPS FOR MAKING A THREE-SIDED DISPLAY

— It's a good idea to get your leader, parent, or other adult to help you.

— Use a material such as hardboard, particleboard, or plywood. Sturdy poster board can be used.

— Open displayed dimensions should not exceed 12 inches deep by 18 inches wide by 22 inches high.

— Use hinges to attach the sections to each other.

— Paint or cover the background with adhesive paper, if you like.

POINTS TO PONDER ON YOUR NATURE WALK

1. Which trees and plants are sun-loving?
2. What animals did you see on your walk?
3. Which layers of the forest did they use?
4. What insects did you see on the forest floor? In the understory? In the canopy?
5. Which layer of trees or plants gets the most rain? Which layer gets the least?

Plan a family outing to a park or forest. Look at the types of resources that are provided for visitors and answer the following questions.

1. What evidence of timber harvesting do you see in the woods? Describe any hiking trails, snowmobile trails, docks on lakes, or other signs of recreation.
2. What things were done to keep the woods beautiful? Were trees left standing along the major roads?
3. What signs of wildlife did you see?
4. What information did you see posted about bears or other animals:
5. Did the air smell clean, and did the water look clear?

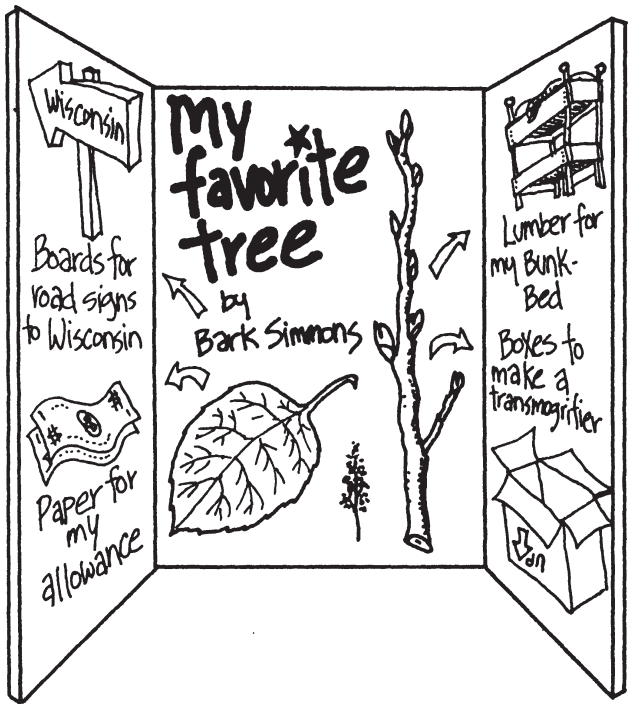
Take this chance to tell your family what you know about multiple-resource management.

ROUNDUP AND FAIR PROJECTS

Draw your favorite tree. Mount the drawing on poster board. Draw some products and benefits we enjoy from this tree (for example, furniture or a place to hang a swing). Do a little research (try an encyclopedia or a book on trees) to list the right products. Different kinds of trees give us different items.

Prepare a display of renewable and nonrenewable resources, using samples (a small piece of wood or a rock, for example) or drawings and photographs. Mount the items on a three-sided display board. Label which items are renewable and which are nonrenewable.

Prepare a display on a job related to the forest (for example, wildlife biologist or forester). Include photos or drawings of different job duties, such as checking survival in tree plantations or managing a timber sale. Mount these drawings on a three-sided display board.



ANSWERS

Re-Tree-Ve the Resource

Across
1. maple syrup
2. picnicking
3. fishing
4. bowling pins
5. toilet paper
6. paper cups

Down
1. camping
2. clean air
3. baseball bats
4. pencils
5. clean water
6. hiking
7. lumber

Renewable/Nonrenewable Quiz

Renewable resources
black cherry, raccoons, sunfish, white ash, and garter snakes.

Nonrenewable resources
natural gas, copper, zinc, diamonds, and coal

Job Match

A. soil scientist
B. truck driver
C. mill technician
D. forester
E. hydrologist
F. logger
G. wildlife manager
H. park ranger

Quiz for the Real Whizzes

1. canopy
2. forest ecology
3. conservation
4. forestry
5. multiple resource
6. renewable resource
7. understory
8. forest floor

Below is a puzzle that has the common names of 14 trees hidden within the letters. Circle the tree names when you find them. The letters can be used more than once and the names can run across, up, down, or diagonally.

H C T A M C A K L O P L O

I S S W A L N U T R I W K

C E B U R O A K A K T H L

K L B I G D E D C L C I Y

O U F I R A E A N E H T S

R C S L I C R U C C P E H

Y R A T G A H M E U I P O

I E M O M Q E V A R N I Z

L H H A Z L L A S P E N T

R E T A R P M O H S L E L

T N U P F R E D P I N E E

B L P N R E H T U O S F A

Answers: sugar maple, oak, white pine, elm, pitch pine, spruce, birch, hickory, red pine, fir, cedar, ash, walnut, aspen

Chapter 2

NAME THAT TREE!
An Introduction to Dendrology

DENDROLOGY FOR YOU AND ME

Have you ever wondered what to call a tree? Each kind of tree has its own name. You need to know how to identify trees if you want to explore each tree's individual traits and uses. The science of tree identification is called **dendrology.**

Trees, just like all other living things, have both a common name and a scientific name. Most people use the common name of a tree. White pine, red maple, and American elm are common names for three trees.

A NAMING PRACTICE

Scientists and technicians use the scientific name for a tree. A tree has only one scientific name but might have more than one common name and may even have the same common name as another tree.

For example, red pine also is called Norway pine, but it has only one scientific name, P*inus resinosa.*

The scientific system of classifying and naming plants, called **taxonomy,** helps foresters and others communicate clearly about trees. Taxonomy organizes living things into groups according to whether they have similar traits.

All living things are divided into two big groups called **kingdoms.** Every living thing belongs to either the plant or the animal kingdom. Each kingdom is then divided into smaller groups, and then those groups are divided into still smaller groups. The last, and smallest, group is called **species.**

Below is an example of the classification of eastern hemlock.

Kingdom.....Plant

Division.....Spermatophyta

Subdivision.....Gymnospermae

Order.....Coniferales

Family.....Pinaceae

Genus.....Tsuga

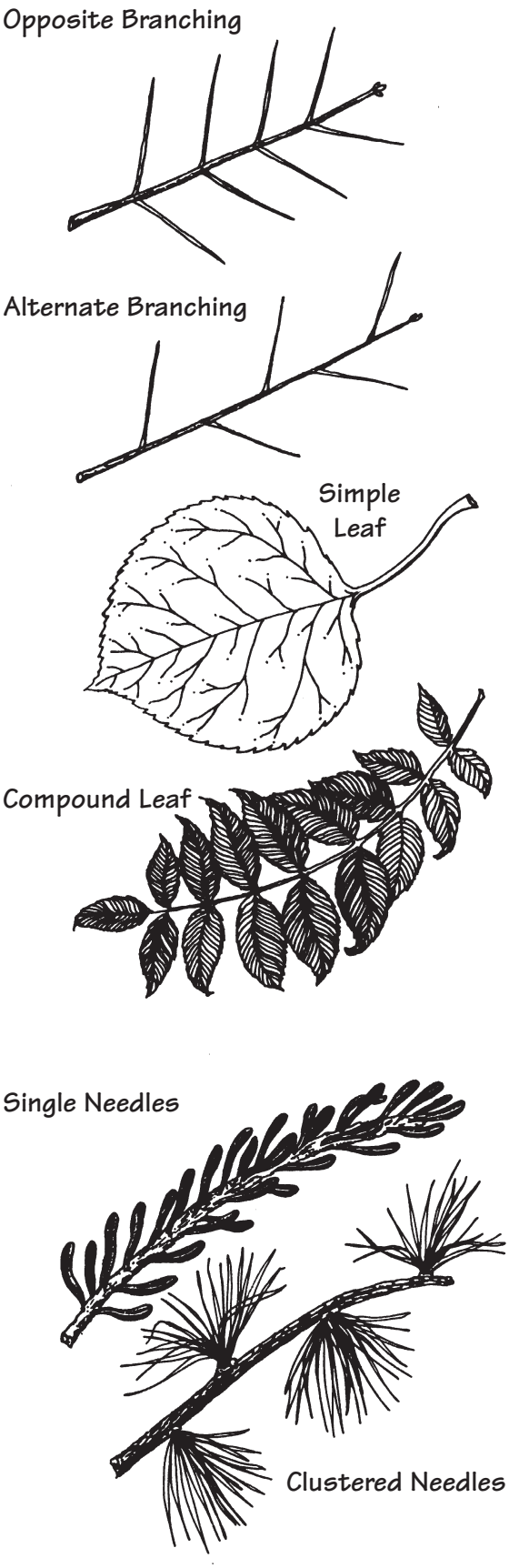
Species.....canadensis

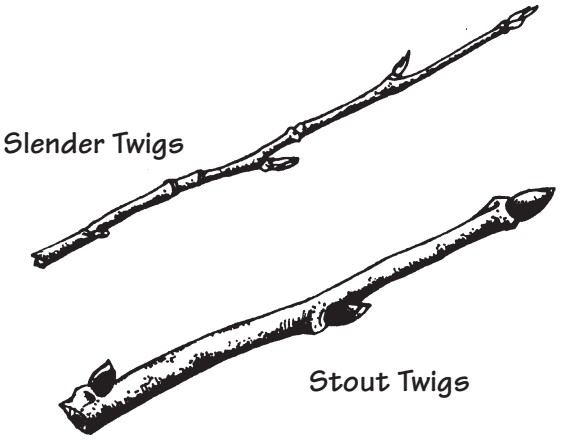
The scientific naming system is based upon the Latin language. Although the Latin names are important for foresters, you will not have to learn them here. Instead, we will focus on common names and tree identification.

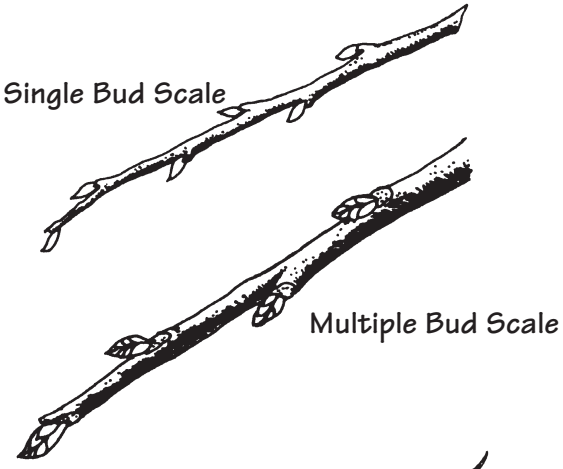
Did you know that leaves are the most common identifying trait of a tree? But what happens when you try to use leaves to identify a tree when it is winter? You'll find some trees no longer have their leaves! Most **coniferous** (remember "cone") trees retain their needles or leaves all winter. Deciduous trees drop their leaves in the fall. That's why it is smart to learn other special features of a tree, too, including:

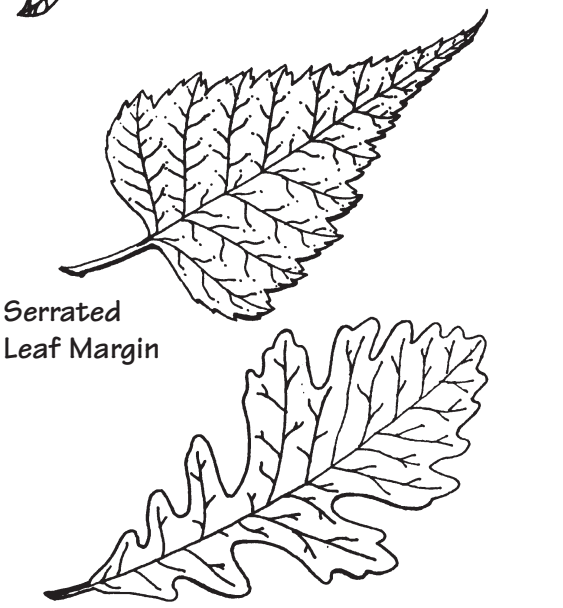
bark	**cones**
fruit	**growth form**
twigs	**buds**
flowers	**peculiar odor**

Some specific identifying traits of trees are illustrated on this page and the next. Outside in your backyard or in a neighborhood park, collect as many leaves and twigs with these traits as you can find. To help people identify unfamiliar trees, foresters and taxonomists have developed special identification charts called keys. Keys help you unlock the identity of a tree species by giving you choices based on traits of the tree.







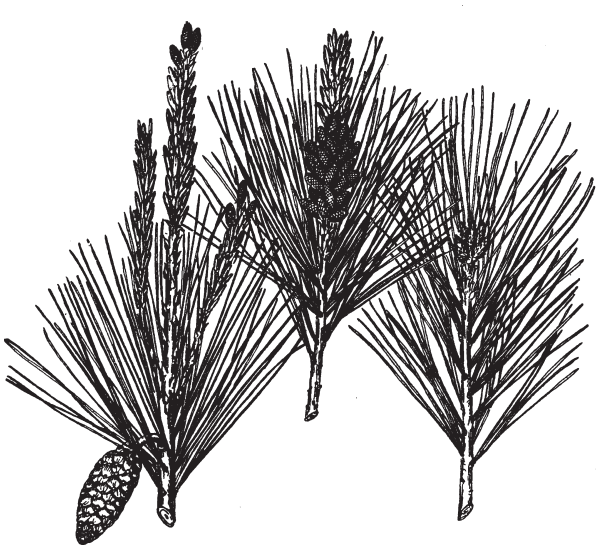


Each time you make a choice, you advance one step closer to learning a tree's name.

You can try your hand at a key by discovering which terrific tree is described below! Start at trait #1 and follow the instructions until you reach the right answer!

WHO AM I ?

I have certain traits that make me different from all the other tree species in the forest. I am special! My needles are borne in groups of five, called a fascicle. They are short and soft.



1. Are the leaves needle-like? ..... Yes! Go to 2a.

2a. Are the needles single on the twig? ..... No! Try 2b.
2b. Are the needles in bundles, tufts, or rosettes? ..... Yes! Go to 3a.

3a. Are the needles in tufts or rosettes? ..... No! Go to 3b.
3b. Are the needles in bundles with sheaths? ..... Yes! Go to 4a.

4a. Are the needles in bundles of 2 or 3? ..... No! Try 4b.
4b. Are the needles in bundles of 5? ..... Yes! Who am I?

Hi! My *name is white pine.*

A Key Practice

Let's classify the tree species in the opposite-branching drawing below. Use the summer key included at the end of this unit.

— First, decide whether the tree has needles or broad and flat leaves. The leaves are broad and flat, so go to 12.

— Next, determine if the leaves are opposite or whorled or alternate. These leaves are opposite or whorled, so advance to 13. Next determine if the leaves are opposite or whorled. These are opposite so go to 14.

— Are these leaves simple, or compound? The leaves are simple, so the next step is 15.

— Compare the leaf with the two choices. Choose the lobed margins. You have identified this tree as a maple.

Here's the Score

Using your yard or a nearby wooded lot, "key out" (identify) the tree species present. For each tree species you identify, write down its common name and the characteristics that helped you identify it.

Species	Identifiers

How many deciduous trees did you identify?

How many conifers did you find?

How many trees did you identify using the leaves only?

How many trees did you identify using other characteristics?

What trait helped you the most in identifying the trees?

Practice using the keys on other trees. First practice on trees you can already name. After you have successfully keyed out trees you know, try to identify unknown trees. The more you practice, the more expert a dendrologist you'll become!

QUIZ FOR THE REAL WHIZZES

Fill in the blanks below using the words at the end. Whiz through this!

1. The smallest taxonomic group is the

   _____.

2. The study of tree identification is called

   _____.

3. _____ is the scientific naming system.

4. The largest taxonomic group is the

   _____.

5. _____ help unlock the identity of different tree types.

Keys

Species

Kingdom

Dendrology

Taxonomy

CAREER CONSIDERATIONS

A **silviculturist** (silviculture means growing trees) decides which tree species will grow best in a certain area. The silviculturist also helps trees reproduce and grow quickly by making sure they have enough sunlight, shade, water, and nutrients. To become a silviculturist, you really have to know your trees and the places they grow best! If you want to be a silviculturist, you can learn about trees at a university or college.

LEAVE THE ANSWER TO ME

Choose several tree species you have identified. Pretend that you are in charge of naming them. What names would you give them? Why?

TREE-VIAL PURSUIT

Mothers have Mothers Day, and ghosts and goblins have Halloween. But do trees have a special day? Yes! Arbor Day is a day set aside each year to honor trees. The first Arbor Day was celebrated in Nebraska on April 10, 1872. Today, Nebraska and all the other states, as well as some parts of Canada, celebrate Arbor Day. In Pennsylvania, Arbor Day is the last Friday in April.

***How do you celebrate* Arbor Day?**
Plant a tree!

YEARNING TO LEARN

Additional Activities

In the following activities, remember some basic rules of conservation. Do not damage or destroy the plants and animals you are studying. Leave all animal homes unchanged. Have a positive impact on the forest.

Make some Forest Flash Cards.

You will need:

stiff cardboard, cut into 5-by-8-inch pieces, or index cards

leaves from different tree species

a heavy telephone book or catalog

a glue stick or rubber cement

clear adhesive paper

Collect and identify leaves from at least eight different tree species Press the leaves between the pages of a heavy telephone book or catalog for at least two days (this will help them dry out). Glue the pressed leaves onto the cards.

On the back of each, in bold letters, write the name of the species and some identifying characteristics. Cover the front and back with clear adhesive paper, trimming the edges close to the card. Use these cards with your friends to test each other's tree identification skills.

Photograph the leaves, twigs, seeds, and trees of at least ten species. Mount these together by species on a poster board, or make a "Family Album" in a regular photo album. Group pictures by tree species (for example, "A Linden Leaf by the Lake" and "A Linden Seed Lying on Loose Soil"). Preserve autumn leaves. Gather some bright colored leaves and small, leafy branches. Spread them on newspapers. Carefully smash the ends of the branches with a hammer to allow them to absorb water. Put them in a jar containing one part glycerine (available from drugstores) and three parts hot water. Set the jar someplace where you can watch the leaves for about a week as they change color and texture. Then you can remove them and use them for decorations. They will stay soft for a long time!

Shape twigs into wreaths

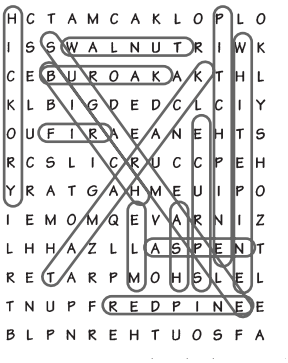
First, identify a tree, such as paper birch, willow, or grape vines, that has slender, pliable twigs. Get permission from the tree's owner to remove twigs from the tree. Cut some twigs and bend them into a wreath or circle. You may need several layers of twigs to form a complete circle. You can use the bottom of a bucket for a form. Lash the twigs together using twine or natural string. Decorate the wreath by gluing on moss, berries, feathers, or other natural material.

ANSWERS

Quiz for the Real Whizzes

1. species
2. dendrology
3. taxonomy
4. kingdom
5. keys

Tree Puzzle



ROUNDUP AND FAIR PROJECTS

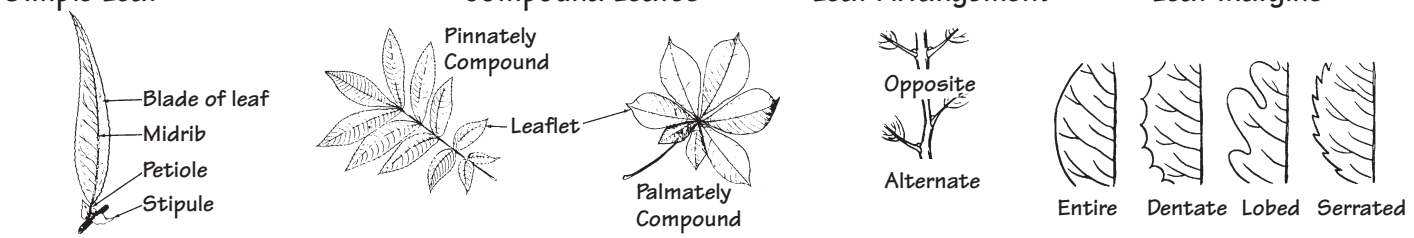
Collect and display leaves, twigs, seeds, or stem/branch cross sections from six or more tree species. The cross section must be at least one inch in diameter, with bark. Label each species. Mount the collection on a three-sided display board or other backing. Your tree samples also can be arranged into a book. If you choose this option, use a leaf collection so the book will close flat.

Make a road map or key to identify six tree species from a collection of leaves. Use just one main group (coniferous or deciduous). Construct the road map to identify these leaves, and attach it to the leaf collection. Point out characteristics used to distinguish each leaf. Draw your road map on poster board, and mount your leaves at points along the way. Use your imagination!

Draw a yard map showing the location of your home and the trees around it. Name the tree species. Collect a leaf, twig, or seed from each tree, and glue it next to the drawing of the tree. Draw the map directly on white or art paper and mount it onto a three-sided display board or other backing.

SUMMER KEY FOR PENNSYLVANIA TREES

If the tree has		go to
1a.	Leaves needle or scale-like	2
1b.	Leaves broad and flat	12
2a.	Leaves scale-like	3
2b.	Leaves needles	4
3a.	Scales pointed, twigs not flat	red cedar
3b.	Scales blunt, twigs flat	white cedar
4a.	Needles (leaves) single on twigs	5
4b.	Needles (leaves) in bundles, tufts, or rosettes	7
5a.	Needles flat, blunt	6
5b.	Needles four-sided and sharp-pointed	spruce
6a.	Needles with small stalks (attaches needle to twig)	hemlock
6b.	Needles without stalks	balsam fir
7a.	Needles in bundles with sheaths at base	8
7b.	Needles in tufts or rosettes	larch
8a.	Needles in bundles of 5	white pine
8b.	Needles not in bundles of 5	9
9a.	Needles in bundles of 3	pitch pine
9b.	Needles in bundles of 2	10
10a.	Needles about 4 inches long	11
10b.	Needles 1.5 to 3 inches long	Virginia pine
11a.	Needles stiff and sharp-pointed	Austrian pine
11b.	Needles flexible	red pine
12a.	Leaves opposite or whorled on stem	13
12b.	Leaves alternate on stem	18
13a.	Leaves opposite on stem	14
13b.	Leaves whorled on stem	catalpa
14a.	Leaves simple	15
14b.	Leaves compound (leaf made up of leaflets)	16
15a.	Margins entire	dogwood
15b.	Margins lobed	maples
16a.	Pinnately compound	17
16b.	Palmately compound	horse chestnut buckeye
17a.	Leaf divided into 3 to 5 leaflets	boxelder
17b.	Leaf divided into 7 leaflets	ash



If the tree has	go to
18a. Leaves simple	19
18b. Leaves compound (leaf made up of leaflets)	39
19a. Margins entire	20
19b. Margins deeply cut, lobed, or toothed	22
20a. Leaf base heart-shaped	redbud
20b. Leaf base tapering	21
21a. Leaves 2 to 4 inches long	black gum
21b. Leaves 5 to 8 inches long	cucumber
22a. Margins deeply cut or lobed	23
22b. Margins toothed	28
23a. Veins palmate, five deeply cut lobes, star-shaped leaf	sweet gum
23b. Veins pinnate	24
24a. Square or notched at top	tulip-poplar
24b. Leaves not square or notched	25
25a. Leaves from one tree may be entire or with one or two lobes	sassafras
25b. Leaves with more than two lobes	26
26a. Lobes regular	27
26b. Lobes irregular	mulberry
27a. Lobes rounded	white oak group
27b. Lobes sharp-pointed with a hair-like bristle on end of each lobe	red oak group
28a. Teeth coarse, one at end of each lateral vein	29
28b. Teeth fine, several for each main lateral vein	30
29a. Leaves slender, 3 times as long as broad	chestnut
29b. Leaves not more than 2 times as long as wide	beech
30a. Leaves very narrow, 4 or 5 times as long as wide	willow
30b. Leaves broad	31
31a. Leaves not over 1.5 times as long as broad	32

If the tree has	go to
31b. Leaves about twice as long as broad	33
32a. Unequal heart-shaped leaf base, round stem	basswood
32b. Leaf base not heart-shaped, sides equal at base, stem tends to be flattened	aspen
33a. Leaves smooth	34
33b. Leaves rough and hairy	35
34a. Leaf stalk with one or two glands, has a sour odor when twig is broken	cherry
34b. Leaf stalk without glands	juneberry
35a. Rough leaves	36
35b. Soft, hairy leaves	37
36a. Leaf margins double-serrate from base	elm
36b. Leaf margins single-serrate from above base	hackberry
37a. Leaf margins double-serrate	birch
37b. Leaf margins single-serrate	38
38a. Leaf margins with rounded or blunt teeth	red mulberry
38b. Leaf margins with sharp teeth	hophornbeam
39a. Sap milky	sumac
39b. Sap not milky	40
40a. Terminal leaflet much larger than other leaflets	hickories
40b. Terminal lealet as large or smaller than other leaflets or it may be lacking	41
41a. Leaflet round-tipped	locust
41b. Leaflet pointed	42
42a. Leaves smooth	43
42b. Leaves hairy	44
43a. Leaves not over 7 inches long	mountain-ash
43b. Leaves over 12 inches long	ailanthus
44a. Terminal leaflet as large as other leaflets	butternut
44b. Terminal leaflet small or lacking	black walnut

Chapter 3

THE LIFE OF A TREE
Seeds and Tree Growth

A NEW BEGINNING

In the woods called "Hearts Content" in the Allegheny National Forest, a grove of Eastern hemlock stands silent, embracing the endless blue sky of an August day. They are old and grand now. But once, years ago, these giants were tiny seeds.

A tree seed contains an embryo (baby) tree. This embryo already has tiny leaves, a stem, and a point that will become a root. The embryo is surrounded by **endosperm**—the food supply for the developing tree.

Once the seed falls from the tree to the ground, it is covered by leaves and soil. When the ground is warm enough and other conditions are just right, the seed begins to grow, using the endosperm for food.

Eventually, the endosperm is consumed. The seed then must seek other sources of nutrients By sending out a root, the seed anchors itself to the ground and draws water and nutrients from the soil.

Finally, the tiny tree emerges from the ground. The leaves appear. They enable the growing tree to produce its own food. The shell, or **seed coat,** of the embryo tree then falls off. Some seeds, such as acorns, have tough, protective seed coats. Other seeds, such as maple, have light coverings.

Seeds are scattered in many different ways. Animals eat seed-bearing fruit and then deposit the seeds on the soil in their scat. Wind carries winged and other light seeds. Sticky seeds often cling to an animal's fur (or your sweater!) and ride along to a new location. Lakes and streams give some seeds a "boat ride" to new areas. And, of course, gravity pulls seeds from the trees, giving them a long ride downhill to a new home.

The shaggy, spreading silver maple drops seeds onto the soil in the early summer. These seeds are already mature. They start to germinate, or grow, shortly after they hit the ground. The nut-bearing black walnut, on the other hand, drops its seeds in the fall. These seeds are **dormant**, and will not germinate until the spring. Dormant seeds must go through a cold spell before they germinate. In nature, winter provides this cold treatment.

Some seeds must be softened before they will germinate. Their tough seed coat can be softened by the digestive systems of animals, such as birds or cattle that eat the seed. For example, grouse eat juniper berries and then disperse the seeds in their droppings.

Seeds from most tree species germinate best on bare mineral soil, which has the moisture that they need. Seeds germinating on leaf litter (leaves scattered on the forest floor) often die for lack of water. Their roots cannot penetrate dry litter to reach the moist soil.

SEED SHUFFLE

Seeds are useful not only for reproducing trees, but also as sources of food for people and animals such as bears, squirrels, and songbirds.

Unscramble the letters below to identify the seed products and write them on the lines.

wasltnu _____

Popular for baking; unique flavor

bnecrierars _____

Grows in bogs; used in holiday baking

carnos _____

Made into flour by American Indians

uconoct _____

Grows in the tropics; seed is big and edible

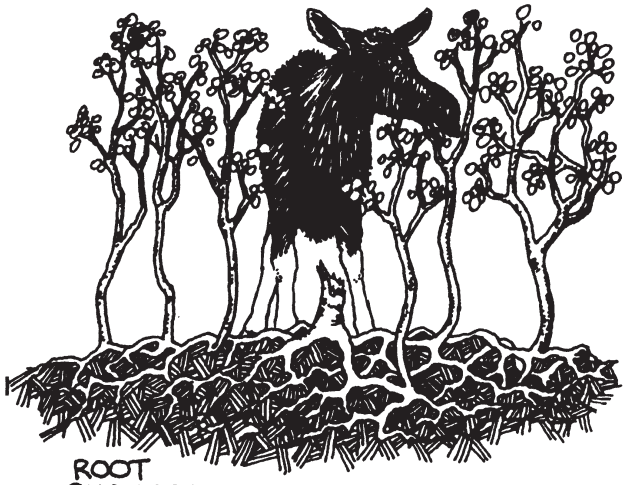
ureiserbelb _____

Bears love these; they make great muffins!

zetushanl _____

Grows on shrubs; squirrels love them.

STUMP SPROUTS



ROOT SUCKERS

LAYERING

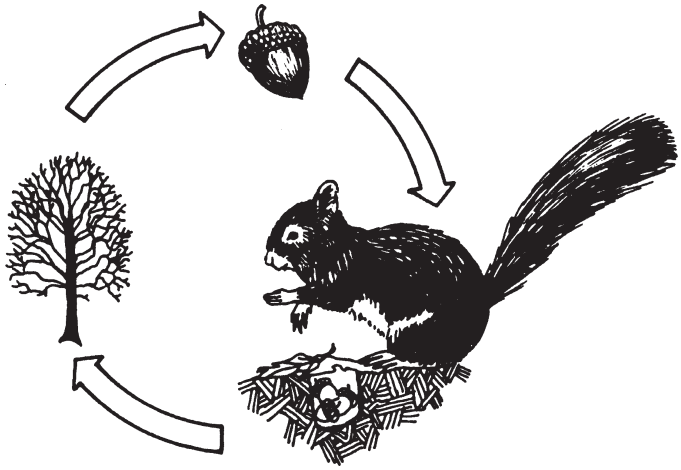
A NEW BEGINNING, PART II

Many trees get their start in life as seeds. But not all! Did you know there are other ways that trees can reproduce?

Stump sprouts develop from the stump of a recently cut tree. They commonly grow from the stumps of deciduous trees such as oak, basswood, red maple, and willow.

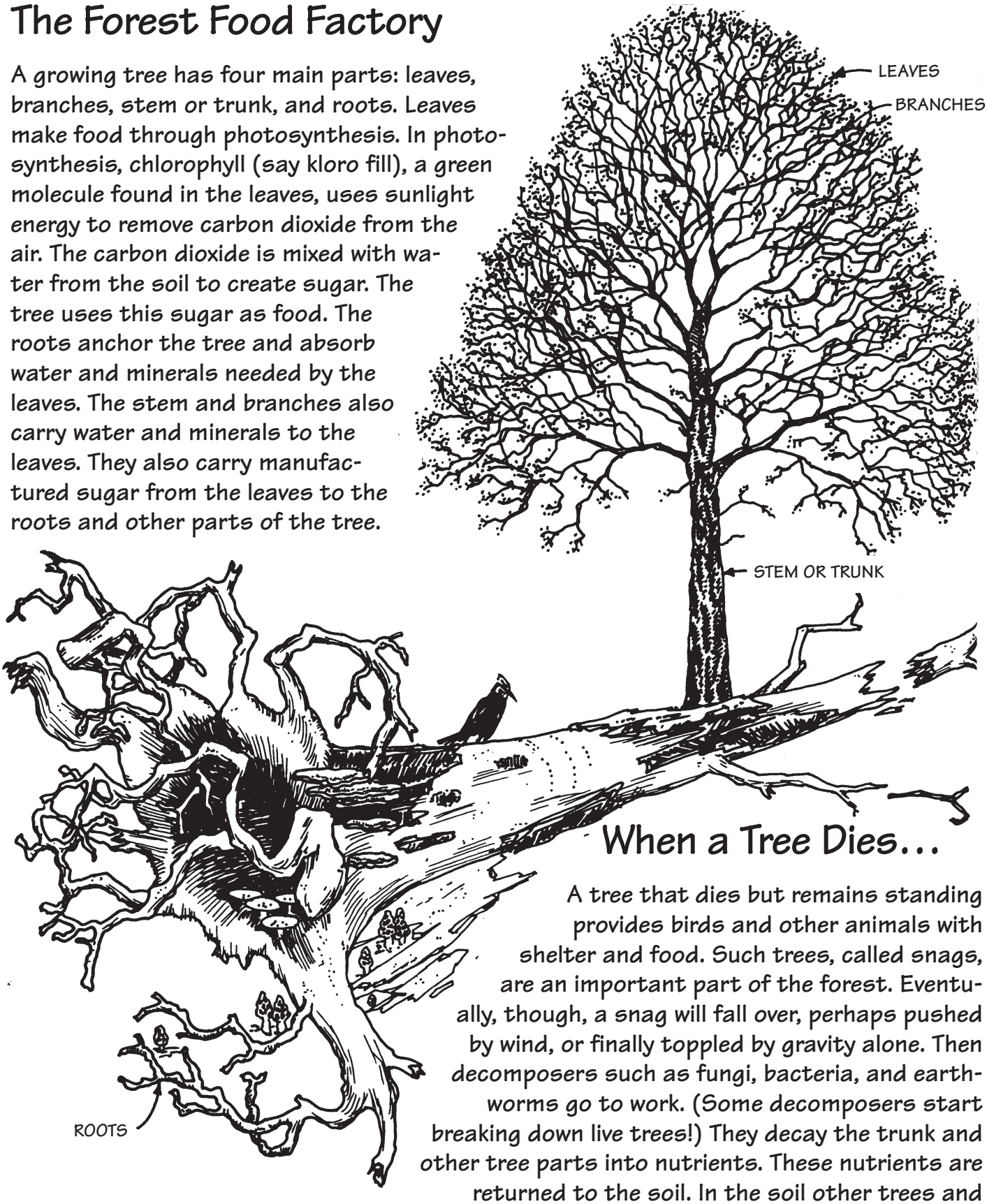
Root suckers are new shoots that develop from special buds on the roots of a few species of trees. Aspen trees grow from root suckers after the parent tree has been harvested. Root suckers grow very fast.

Layering occurs when the branch of a living tree touches the ground, becomes covered by leaf litter or soil, and takes root. A new tree is created at this junction. Northern white-cedar is one tree that can reproduce by layering.



The Forest Food Factory

A growing tree has four main parts: leaves, branches, stem or trunk, and roots. Leaves make food through photosynthesis. In photosynthesis, chlorophyll (say kloro fill), a green molecule found in the leaves, uses sunlight energy to remove carbon dioxide from the air. The carbon dioxide is mixed with water from the soil to create sugar. The tree uses this sugar as food. The roots anchor the tree and absorb water and minerals needed by the leaves. The stem and branches also carry water and minerals to the leaves. They also carry manufactured sugar from the leaves to the roots and other parts of the tree.



When a Tree Dies...

A tree that dies but remains standing provides birds and other animals with shelter and food. Such trees, called snags, are an important part of the forest. Eventually, though, a snag will fall over, perhaps pushed by wind, or finally toppled by gravity alone. Then decomposers such as fungi, bacteria, and earthworms go to work. (Some decomposers start breaking down live trees!) They decay the trunk and other tree parts into nutrients. These nutrients are returned to the soil. In the soil other trees and plants can use these nutrients again. Nature is the ultimate recycler.

Growing...Growing...Grown!

We have looked at several ways in which a mighty tree starts its life. But how does a tree grow from a tiny shoot into a forest giant?

Trees undergo three different kinds of growth:

height

diameter

root

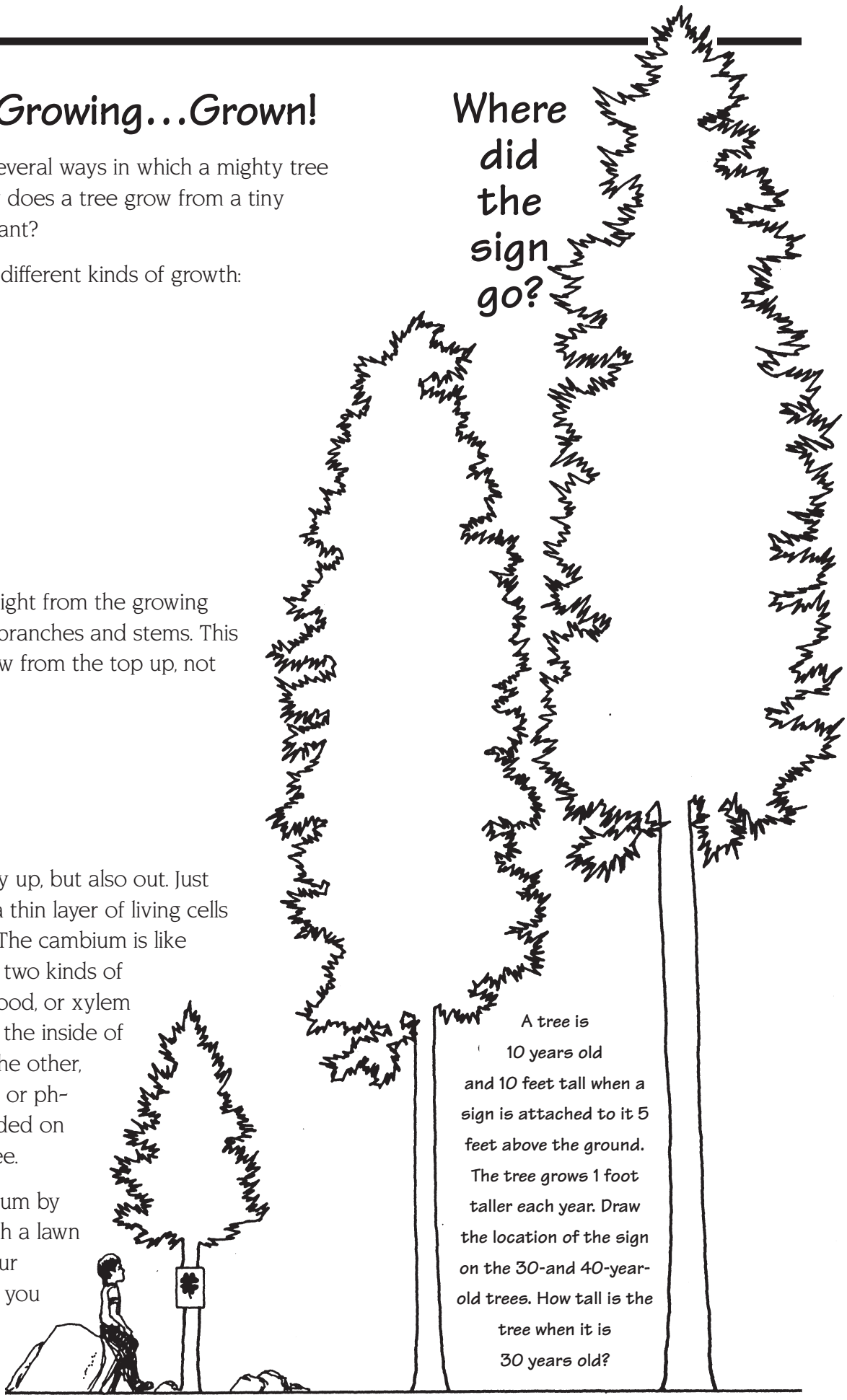
Height Growth

A tree expands in height from the growing points at the end of branches and stems. This means that trees grow from the top up, not from the ground up.

Diameter Growth

A tree grows not only up, but also out. Just beneath the bark is a thin layer of living cells called the cambium. The cambium is like a factory that makes two kinds of products. One, the wood, or xylem (zi-lem), is formed on the inside of the cambium layer. The other, called the inner bark, or phloem (flow-em), is added on the outside of the tree.

If you hurt the cambium by bumping the tree with a lawn mower or carving your initials into the trunk, you damage the tree's factory.



Root Growth

Roots expand in diameter from a cambium layer also. They grow longer from their tips, just like branches and main stems do. The major difference is that roots grow down instead of up.

THE HEART OF THE STORY

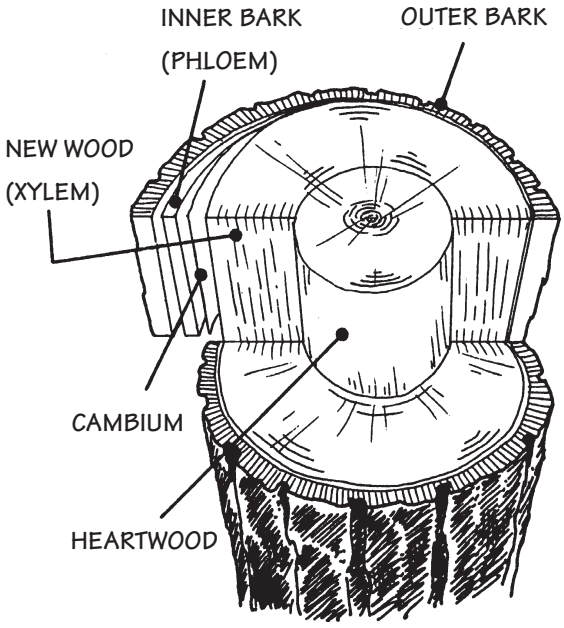
Outer bark is the "skin" of the tree. Outer bark does several things. It protects the tree from injury. The bark is a barrier to insects and diseases. It also insulates the tree from winter cold and summer heat.

Inner bark (phloem) has tubes through which food travels from the leaves down to the branches, stem, and roots. When phloem cells die, they become part of the outer bark.

New wood (xylem) carries minerals dissolved in water upward from the roots.

A **cambium** cell layer is wrapped around the wood. It makes new bark (phloem) and new wood (xylem) every year.

Heartwood is the backbone of the tree. Heartwood is not living wood. It supports the tree. It also is the place where many waste products from the tree collect.



QUIZ FOR THE REAL WHIZZES

Fill in the blanks below using the words at the end. Whiz through this!

1. Seeds that go through a period of cold before they germinate are called _____.
2. _____ is a thin layer of growing cells between the inner bark and new wood.
3 _____ is the conversion of water and carbon dioxide into a sugar.
4. The _____ support the tree's crown and serve as a transport line for sugar and water.
5. When a seed _____, it starts growing.
6. The cambium produces _____ and _____.
7. Dark, narrow rings of wood are called _____.
8. The _____ anchor the tree and absorb water and minerals from the soil.
9. _____ are the food factories in a tree.
10. Light, wide rings of wood are called _____.
11. _____ is a green material in leaves that is used to make sugar.

cambium	**photosynthesis**
chlorophyll	**roots**
dormant	**springwood**
germinates	**stem and branches**
leaves	**summerwood**
phloem	**xylem**

DIARY OF A PAPER BIRCH

I am a paper birch. The drawing on the next page shows a cross section of my trunk. Throughout the spring and summer, I add new layers of wood to my trunk. The wood I make in spring **(springwood)** grows very fast, and is lighter colored because the cells are large. The wood I make in the summer **(summerwood)** grows much more slowly, and the wood is dark because the cells are small. Each year's growth of light and dark wood is called an **annual ring.** Count my dark rings, and you will know my age. If you study my annual rings closely, you can learn my life story.

At 16 years of age, I was growing fast. That year I got lots of sunlight and plenty of rain. That year, the trunk of another tree leaned against me, tilting me at an angle. In order to stand upright again, I made my rings wider on the lower side. This extra growth, called **reaction wood,** helped me to balance myself.

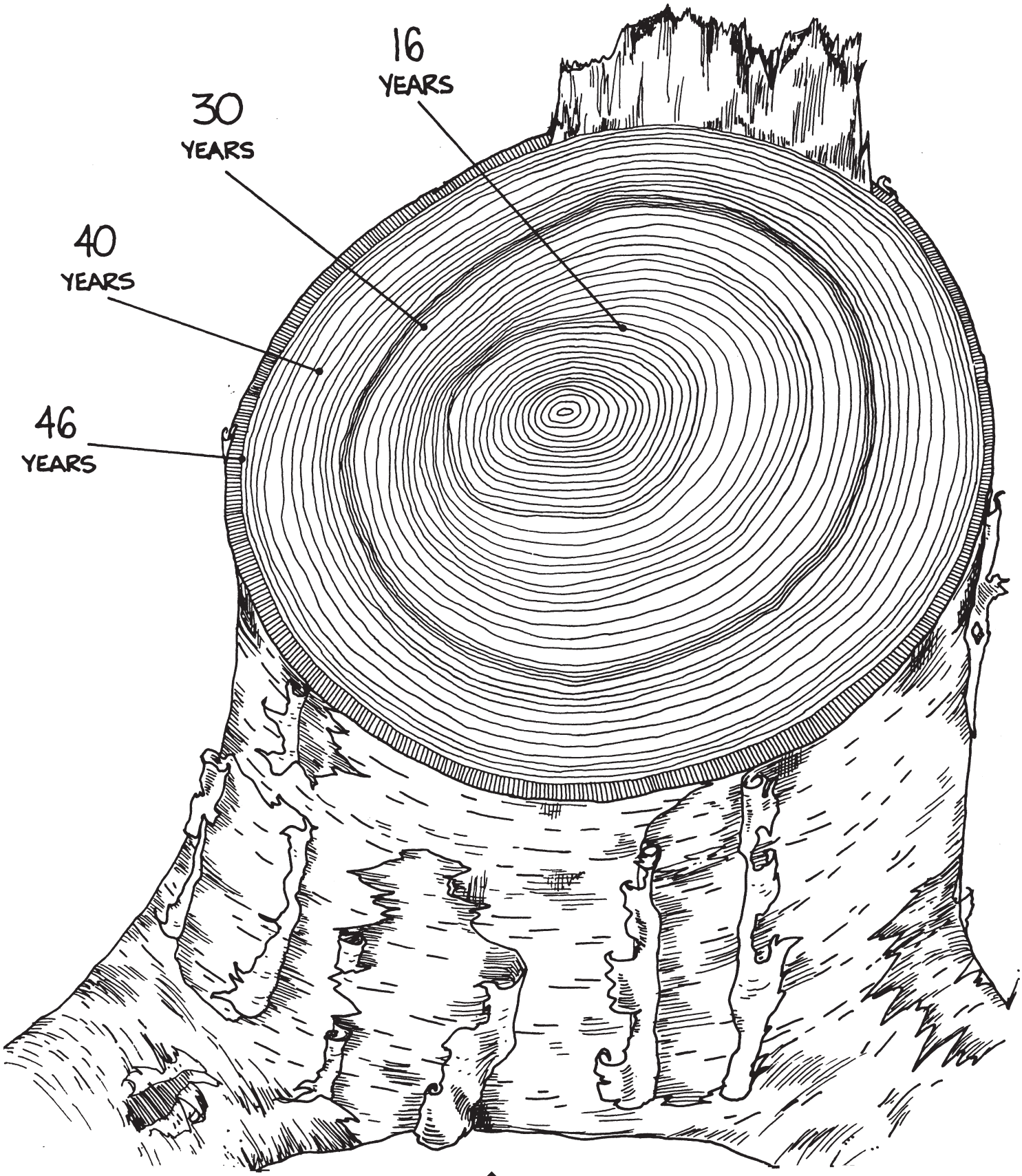
When I was 30 years old, a terrible drought hit this forest. It lasted four years. I grew very slowly in those years, so my rings are very narrow. I thought I would soon be food for the decomposers, but I managed to survive.

At age 40, the forest had thinned from the last drought, so I had room to grow again. I didn't have to compete with so many other trees for sun, water, and nutrients.

Now I am 46, and quite naturally my growth is slowing a bit. I have enjoyed my life in the forest. I enjoy watching all the changes.

My scientific name is:

Betula papyrifera

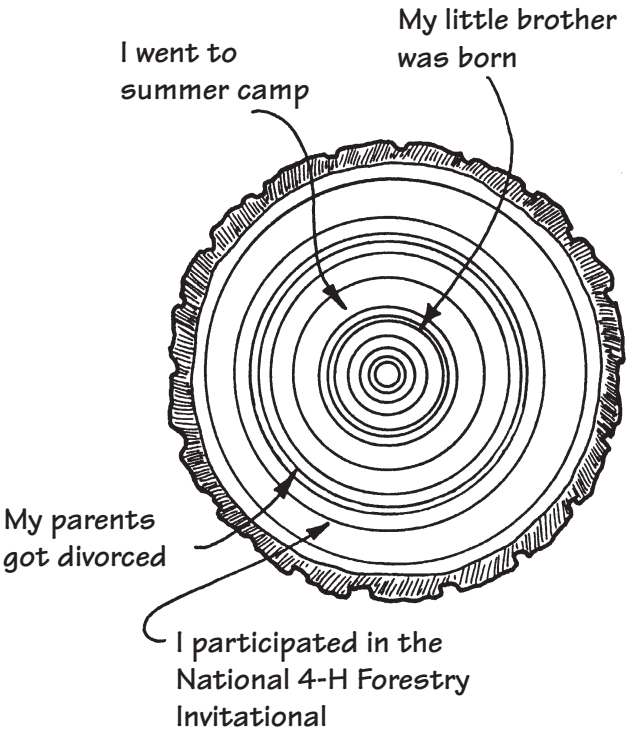


CAREER CONSIDERATIONS

A wood scientist develops useful products from wood. These scientists may work in laboratories of private industries, universities, or governmental agencies. To become a wood scientist, you may start at a university or college in the department of wood products. Scientists are like sleuths. They look for clues that no one else can see!

LEAVE THE ANSWER TO ME

Trees' annual rings show what their growing conditions were like. Pretend that you have annual rings. Draw your own life story. Which years did you have wide rings (good growing conditions)? Did you have any narrow rings? Here's an example for you?



TREE-VIAL PURSUIT

Do you know how leaves change color? The bright, clear days of autumn trigger leaves to produce large amounts of sugar. The cool nights slow down the movement of the sugar, trapping it in the leaves.

Sugar kept in the leaves causes an increase in the production of certain chemicals that cause bright coloration. At the same time, the production of chlorophyll, which is green, drops.

YEARNING TO LEARN

Additional Activities

In the following activities, remember the basic rules of conservation. Do not damage or destroy the plants and animals you are studying. Leave all animal homes unchanged. Have a positive impact on the forest.

Collect and germinate seeds from a tree in your neighborhood. The kind of seed you should use depends on the time of year.

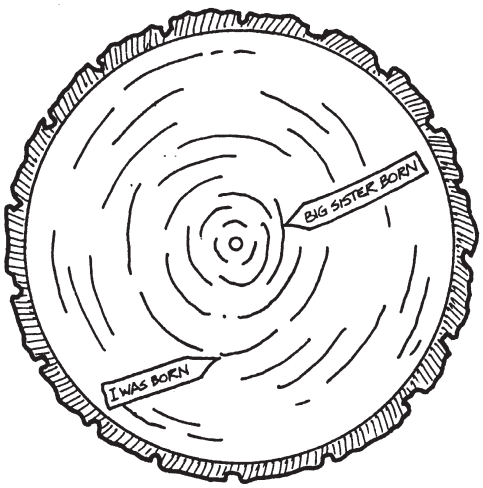
In the spring you will have the best luck with elm, red maple, or silver maple seeds. Plant these seeds in a pot of regular soil. Cover them with one-fourth of an inch of soil and keep the soil moist. Keep track of how many days it takes for the seeds to germinate. It may take a few weeks so be patient!

If you collect seeds in the fall, you will have the best results with pine seeds. You can plant seeds from red pine as soon as you collect them. White pine seeds will need a pretreatment. To pretreat these seeds, place a moist paper towel on a small plate. Put the seeds on the paper towel and cover them with another moist paper towel. Place this seed "sandwich" on a dish in the

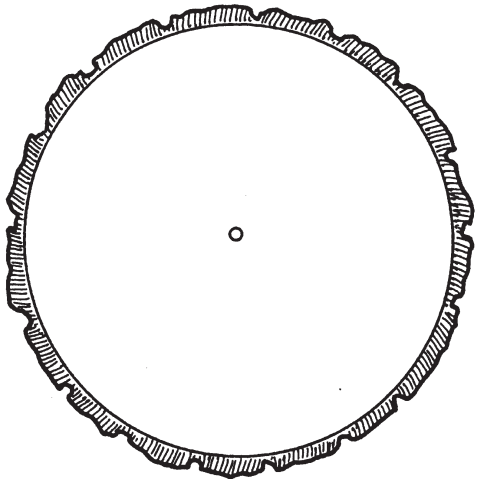
refrigerator. Keep the paper towel moist. Change the paper about once a week. After about 60 days, remove the seeds and plant them in a pot one-fourth of an inch deep containing regular soil. Keep the soil moist.

Hunt for seeds in the woods. Collect as many different kinds of seeds as you can find. Where did you find these seeds? Were they on the ground, hanging from a branch, or floating on a lake? Are the seeds heavy? Are they big or small? How do you think they got to where you found them? Which (if any) are seeds that animals might eat?

MAKE A FAMILY TREE!



Obtain a cross section of wood at least 2 inches in diameter, preferably from a tree that is at least 40 years old. Starting from this year's growth, count back the rings and label the ring that grew the year you were born. (Use a small label and glue.) Do this for other members of your family, too. Draw your own family ring history here:



ANSWERS

Seed Scramble

1. walnuts
2. cranberries
3. acorns
4. coconut
5. blueberries
6. hazelnuts

Growing...Growing...Grown!

When 30 years old, the tree is 30 feet tall. The sign is always at 5 feet above the ground because trees grow in height from the top, not from the bottom.

Quiz for the Real Whizzes

1. dormant
2. cambium
3. photosynthesis
4. stem and branches
5. germinates
6. xylem-phloem
7. summerwood
8. roots
9. leaves
10. springwood
11. chlorophyll

ROUNDUP AND FAIR PROJECTS

Make a seed collection using at least eight different species. Group them according to how the seeds travel. For example, your groups might include seeds distributed by animals, seeds eaten by birds, and seeds that float in the wind. Display your seeds in a box or glue them onto a three-sided display board. Also display each species' seed cut in half, to show the inside.

Prepare a display showing the life and death of a particular tree. Use drawings or models to show how this tree began life as a seed or by suckering, stump sprouting, or layering. Draw or build a model of the tree as a healthy adult, and then as a log on the forest floor. Illustrate what is happening to the log as it is decomposed. Use drawings, pieces of moss, leaves, and other forest matter to construct the display. Use either a three-sided display board or a box for your project.

Make a display based on a cross section of a tree stem. Your cross section should show at least 20 years' growth. Study the growth ring patterns and figure out this tree's "life story." Note which years were good and which were tough. Label your cross section with dates, and prepare a short report explaining the annual ring patterns.

Chapter 4

CHANGE IN THE FOREST
FOREST SUCCESSION
The Forces of Change

Centuries ago, Pennsylvania was covered with pine and hemlock forests. Then the settlers came, bringing saws and plows. One by one they cut the towering hemlock and white pine trees until only stumps and hardwoods remained. Fires started by passing trains or by the settlers burned through these areas. As farms grew, the number of pines and hemlocks decreased. Change came to the forest.

Various hardwoods, an important part of the original forest, now ruled the areas where pine and hemlock trees reigned. A new cycle of **succession,** the gradual change in the type and amount of plants in an area, had been started by the settlers.

Fire, logging, plowing, and other events sometimes disturb an area of land. When formerly dominant plants and trees are removed, succession begins. New plants take over the area where the old plants once lived.

Mark an "X" by the events that might start succession in a forest

_____ **tornado**

_____ **hurricane**

_____ **floods**

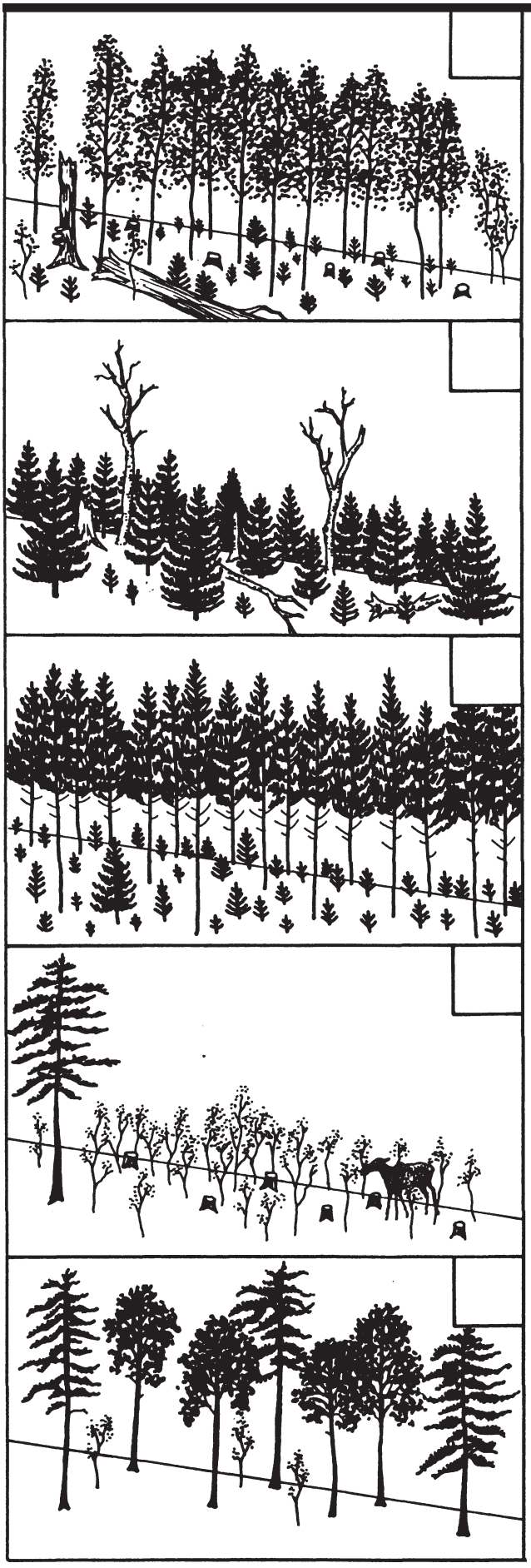
_____ **drought**

_____ **logging**

_____ **fire**

_____ **large numbers of insects**

_____ **plowing/land clearing**



MADE IN THE SHADE

When you remove trees, you take away the shade for new trees on the ground. The first new seedlings to grow in this area often like sunlight, but not shade. Aspen, paper birch, cherry, and ash are some common **shade intolerant** plants, also known as **pioneers**.

Once shade intolerant trees settle into an area, they make a bit of a problem for themselves. Younger pioneer trees can't grow up in the shade of their taller parents. The younger pioneer trees, remember, need lots of sunlight. This means that different tree species will start to take over beneath the parents.

These other tree species are shade tolerant—they can grow and reproduce in the shade. Shade tolerant tree species include sugar maple, American basswood, American beech, and hemlock. When the pioneers die out, the shade tolerant trees dominate the area.

A **climax** forest is a forest in which the overstory trees are the same species as the understory trees. Climax trees remain until fire, harvesting, or another force disturbs the area again.

In the drawings on the left, label the correct series of events in the succession. Use a "1" for the first stage, "2" for the second, and so on, until you reach a climax forest.

THERE'S NO PLACE LIKE HOME

Animals are very particular about their surroundings. Every animal has a specific environment, or habitat, that it likes the best. This preferred habitat meets that animal's special needs for food, water, shelter, and space.

When a forest changes, the animal species that live there also change. Different stages of succession are ideal habitat for different types of wildlife.

Some animals are **generalists** because they like many types of habitats. The black bear likes berries found in the early successional stages of a forest. Yet the bear also needs mature forests for shelter.

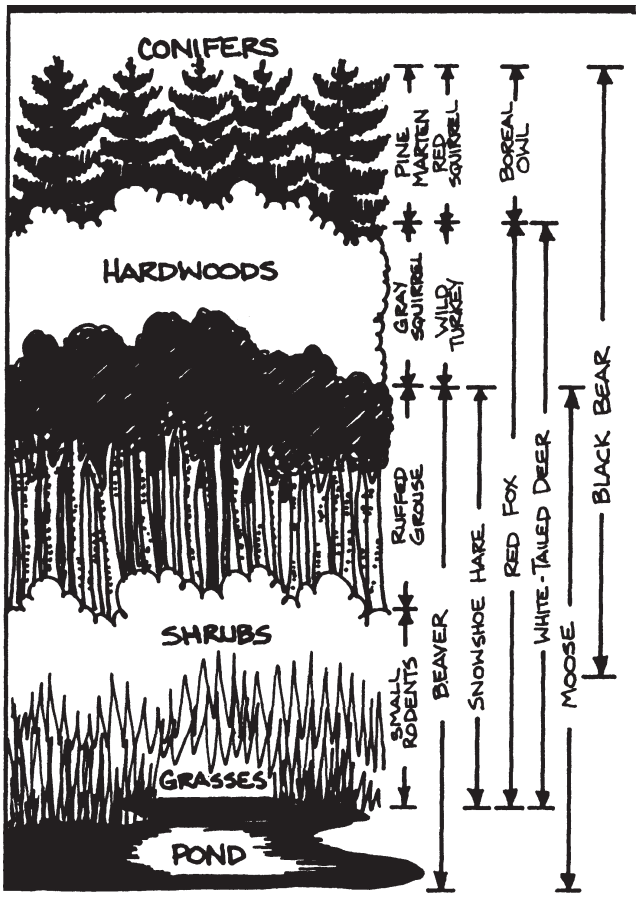
In the Pacific Northwest, the northern spotted owl needs old forests of Douglas-fir and western hemlock. The northern spotted owl is a specialist because it survives best in one type of habitat.

When a habitat is changed, either by people or by nature, it can't support the same animals.

SUCCESSION AND PRODUCTS

Forest succession also affects the types of products a forest produces. A forest in the early stages of succession has many shade intolerant trees. These trees—ash, cherry, and oak—make good wood products. Often foresters will try to slow or stop succession, so that these favored trees can grow.

Other products need a climax forest. Sugar maple is needed to make maple syrup. Woodland owners who want to produce syrup will often try to make this successional stage last.



In this picture, which animals would you call specialists. Why? Which animals would you call generalists? Why?

pine marten: _____

small rodents: _____

ruffed grouse: _____

gray squirrel: _____

beaver: _____

wild turkey: _____

red squirrel: _____

red fox: _____

boreal owl: _____

snowshoe hare: _____

moose: _____

black bear: _____

white-tailed deer: _____

SHADE TOLERANCE

Intolerant

red pine

black cherry

black walnut

paper birch

quaking aspen

black willow

white ash

Intermediate

eastern white pine

red maple

oaks

American elm

Tolerant

eastern hemlock

sugar maple

ironwood

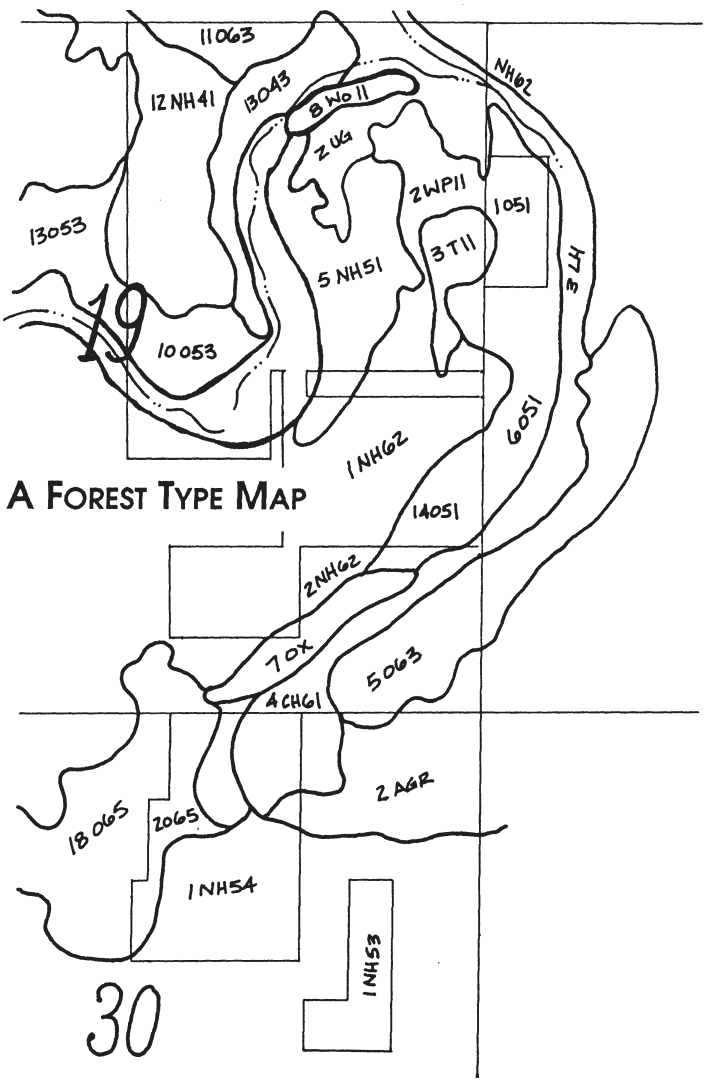
American basswood

American beech

FOREST TYPES

Each forest is a special blend of tree species growing together in one community. This collection of tree species is not random. Certain tree species occur together because they need similar soils, water, and light. We call a collection of species that occur together a **forest type**.

Forest types are named for their main tree species. Quaking aspen and paper birch rule an aspen-birch forest type, although other tree species also can be found there. Foresters often map the location of forest types. The map helps them decide how to manage certain areas.



A FOREST TYPE MAP

See if you can match each tree species below with the forest type where it would be found. More than one species can match each forest type.

SPECIES NAME	FOREST TYPE
bigtooth aspen	**maple-basswood**
white oak	
black cherry	**oak-hickory**
white birch	
eastern white pine	**black cherry-maple**
red oak	
sugar maple	
shagbark hickory	**pine-hemlock**
red pine	
American basswood	
eastern hemlock	**aspen-birch**

CAREER CONSIDERATIONS

Wildlife managers conduct habitat improvement programs, and monitor wildlife populations. They also teach the public about game (hunted animals, such as deer and moose) and nongame (animals that aren't hunted, such as songbirds) wildlife. You'll have to know a great deal about animals to be a wildlife manager. A good place to start is at a college or university.

QUIZ FOR THE REAL WHIZZES

Fill in the blanks below using the words at the end. Whiz through this!

1. A _____ is an animal that can use many different types of habitat.
2. A collection of tree species that occur together is a _____.
3. _____ plants and trees love shade.
4. A gradual change in the type and amount of trees over a long period of time is called _____.
5. An animal that requires a certain type of habitat is a _____.
6. Invading intolerant plants also are called _____.
7. Plants that do not like shade are called _____.
8. A _____ forest exists when the tree species in the overstory are the same species found in the understory.

Answers:	**forest type**	**pioneers**
	climax	**intolerant**
	tolerant	**succession**
	specialist	**generalist**

LEAVE THE ANSWER TO ME

Are you a specialist or a generalist? What type of habitat do you prefer the most?

TREE-VIAL PURSUIT

The male ruffed grouse claims a territory in the spring by jumping up on logs and making a loud drumming sound. He does this by beating his wings back and forth dozens of times every second. Can you move that fast?

YEARNING TO LEARN

Additional Activities

In the following activities, remember the basic rules of conservation. Do not damage or destroy the plants and animals you are studying. Leave the animal homes unchanged. Have a positive impact on the forest.

Choose one animal that lives in the forests around you. Find out what habitat it requires for food, shelter, and space. "Shelter" can include areas for nesting, sleeping, hibernation, and also escaping from predators or bad weather. Give a short presentation on which stages of forest succession your animal would need to meet these requirements.

Stake out and study an area of forest approximately as big as an average yard (40 feet by 40 feet). This forest can be a community forest within a city park or a forest you see while on a camping trip. Count trees that make up the overstory and identify each. Determine the forest type from the list of forest types on page 33.

Remember, forest types are named after the tree species that occur most often. If the species you find do not fit into a given type, name your own type using the two most common species in the plot you study.

Tree Species	Number of Trees in Plot

Forest Type: _____

ROUNDUP AND FAIR PROJECTS

Observe succession in your own yard as a long-term project. Isolate, with some type of temporary fencing, a 4-foot by 4-foot area in your yard. Clear all the plants from this square to expose bare soil. Spade the area and remove any roots you find. Do not water, mow, or fertilize. Observe this area once a month. At each visit,

note the plants that are growing. Are they weeds, grasses, shrubs, or trees? If tree seedlings appear, try to identify them to the genus level (for example, oak, pine, or aspen).

Photograph or sketch your plot each time you visit it, and record the date. Continue this activity for at least two years. Don't expect a climax forest; that usually takes a few hundred years!

After at least two years, prepare a display using photographs or sketches and the information you gathered to illustrate the different plants that invaded the area over time.

You also could build a model to illustrate the succession you observed—use forest materials, twigs, and other materials that resemble the plants you observed. (This activity is adapted from *Project Learning Tree, Activity Guide for Grades 7–12*, American Forest Institute, 1977.)

Prepare a display that illustrates wildlife found in at least two different forest types. For each forest type, do the following?

- Photograph or collect pictures of the forest type.
- Identify the common tree species in the forest type.
- Identify at least two wildlife species found in that forest type.
- Include a picture or photograph of the animals mentioned. Mount your photographs or pictures on a three-sided display board or in a box.

Expand on the forest typing activity **from page 34.** Gather tree species data for at least three distinct forest types in the area. Then map the area. Mount the map on a three-sided display or poster board along with your forest data sheets.

ANSWERS

Succession Disturbances

All of these events are capable of starting succession.

Succession Series

top to bottom: 3; 4; 5; 2; 1

Specialist/Generalist Quiz

Specialists	Generalists
small rodents	snowshoe hare
ruffed grouse	red fox
gray squirrel	white-tailed deer
wild turkey	black bear
red squirrel	beaver

Forest/Species Match

maple-basswood: sugar maple, American basswood

oak-hickory: white oak, red oak, shagbark hickory

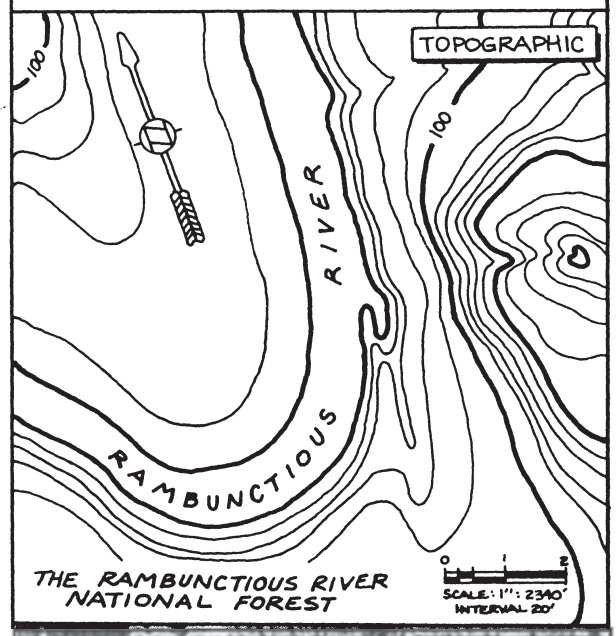
black cherry-maple: black cherry, sugar maple

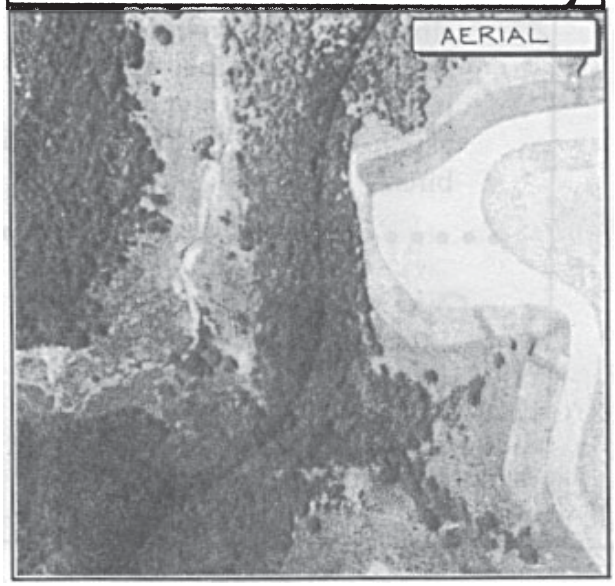
pine-hemlock: eastern white pine, eastern hemlock

aspen-birch: bigtooth aspen, white birch

Quiz for the Real Whizzes

1. generalist
5. specialist
2. forest type
6. pioneers
3. tolerant
7. intolerant
4. succession
8. climax





Chapter 5

FINDING YOUR WAY
Compass and Map Use

ORIENTEERING

Orienteering is the art of using a map and compass together. The purpose is to find your position and then to find your way through an unfamiliar area. In a sense, it's a way of staying "unlost." Before you can master orienteering, you have to be able to read a compass and a map. Using a compass, a map, and your legs, you can chart your course through the wildest forest thicket.

Foresters practice orienteering in their daily work. Foresters rely heavily on maps and compasses to help them find their way through the woods. For instance, they use their orienting skills in inventorying a forest stand. They also use these tools and skills in surveying and marking boundaries for a timber sale. Foresters cannot afford to get lost in the woods!

MAPS

A map is a drawing of part of the earth's surface. Two common types of maps are **topographic** and **planimetric**.

A topographic map shows changes in elevation. An aerial photograph—a picture taken from an airplane—shows contour and can be used as a map. Topographic maps or aerial photographs are used in orienteering.

A planimetric (plani means plane, or flat) map does not show where the land gets higher or lower. It is two-dimensional. Road maps most often are planimetric.

All planimetric and topographic maps share some important features.

- The legend or key explains what the map symbols represent on the ground.
- The north arrow tells which direction is true north on the map. (In many cases, north is at the top of a topographic map.)
- The scale tells how much real distance is represented by each unit of measurement on the map. For example, a scale of 1:24,000 means that 1 inch, centimeter, foot, or mile on the map equals 24,000 inches, centimeters, feet, or miles on the ground.
- The title tells what the map represents.

You can order a topographic map of your area from the U. S. Geological Survey. Each state has an index that shows which maps are available. A book describing maps and indexes can be ordered from:
U. S. Geological Survey
Federal Center, Distribution Section
Denver, CO 80225
Your parent, leader, or county extension agent can help you.

READING A TOPOGRAPHIC MAP

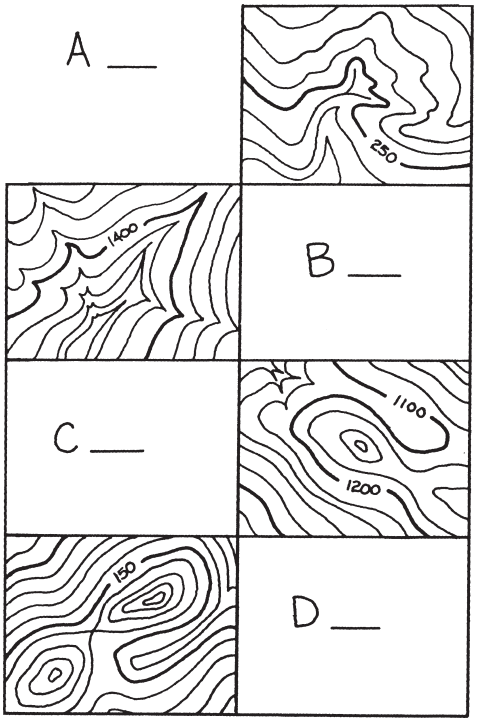
The most obvious way in which topographic maps differ from other maps is that they contain many thin, curved lines that appear to wrap around certain areas. These lines are called contour lines. They connect points of equal elevation. This means that if you were to walk along the ground represented by a contour line, you wouldn't go uphill or downhill.

A topographic map will tell you whether an area is steep or level. Places where the lines are close together are very steep. Where the lines are far apart, the land is relatively flat. The actual elevation is written on every fifth line. In the United States, we measure elevation beginning with 0 feet at sea level.

Contour lines have four important characteristics:

1. All points along the same contour line are at the same elevation.
2. All contour lines eventually connect with themselves.
3. Contour lines never cross each other.
4. Contour lines never split or branch.

Each drawing below violates a rule of contour lines. Match each rule with the drawing that violates the rule.



GETTING TO KNOW YOUR COMPASS

The earth is a gigantic magnet. The north magnetic pole attracts the north end of your compass's magnetic needle.

Compass dials are marked clockwise from 0 to 360. There are 360 degrees in a circle. The ° symbol is sometimes used to mean degree or degrees.

NORTH is 0 or 360 degrees

EAST is 90 degrees

SOUTH is 180 degrees

WEST is 270 degrees

Each 90-degree section is called a **quadrant**. Think of a pie cut into four equal sections (quad means four). Each section is one quadrant.

Quadrants are assigned directions of northeast (NE), southeast (SE), southwest (SW), and northwest (NW). A person traveling at 220 degrees would be traveling to the south and to the west, or southwesterly.

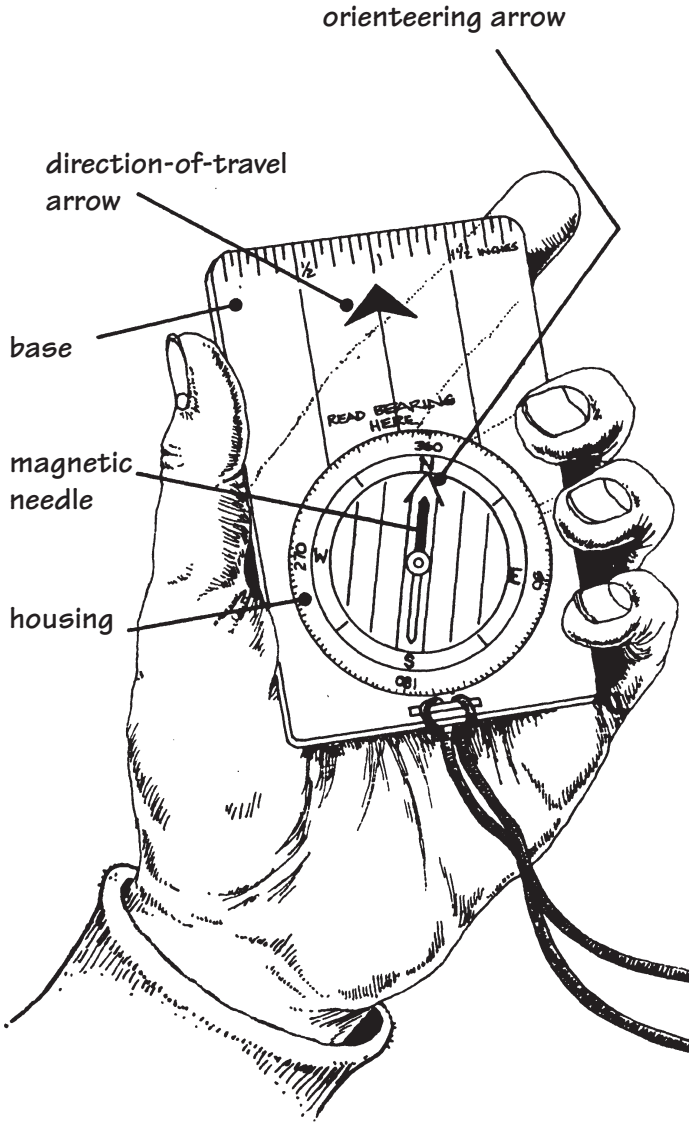
Fill in the correct quadrant readings below. Two are done for you as an example.

Reading	*Quadrant*
240°	SW
232°	_____
7°	_____
316°	_____
90°	Due east
107°	_____
0°	_____

***To take a bearing*:**

1. Stand facing a tree or other marker.
2. Hold the compass flat in the palm of your hand near your chest with the direction-of-travel arrow pointing directly at your marker.
3. Turn the compass housing until the painted portion of the **magnetic needle** and the **orienteering arrow** point in the same direction.
4. Read the direction at the spot labeled *read bearing here*. This is your bearing.

Note: Do not hold your compass near a belt buckle or other metal object. The metal can skew the reading.



PACING YOURSELF

To use a map and compass to find your way in the woods, you need a way of measuring distance. Since it is not practical to use a ruler or tape to measure distance in the woods, your **pace** will serve as a handy measuring device.

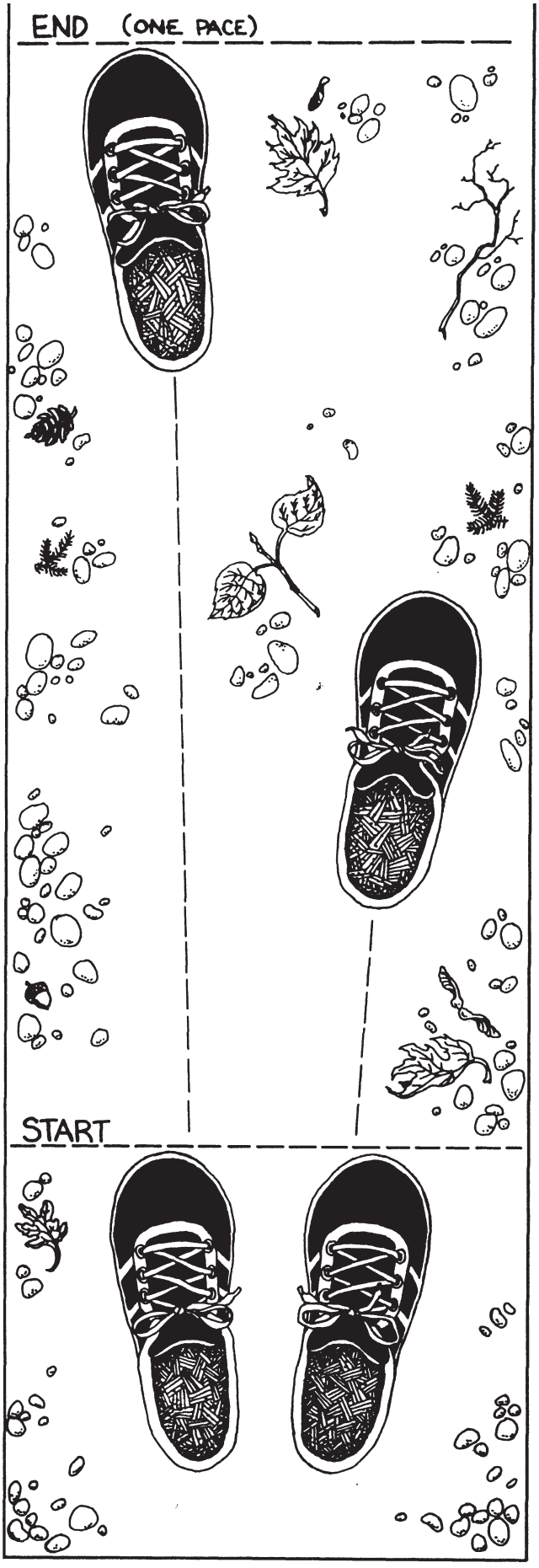
How To Find Your pace

First, find the length of your pace. A pace is the length of your stride while walking (a double step). Your pace may be different from anyone else's pace.

To find your individual pace, measure 100 feet on the ground with a tape measure and mark the beginning and ending point. Starting with your **right** foot, walk from the beginning to the end, counting a pace every time your **left** foot hits the ground. Use a natural walk, not extra large or small steps. Pace the 100-foot distance three times and average your number of paces. Round off the number.

Enter your pace here:

_____



ORIENTEERING ON YOUR OWN

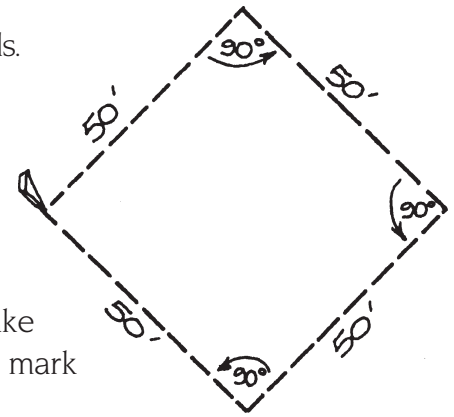
Orienteering, as we noted before, is the process of traveling through the forest using a map and compass, usually with a goal in mind. Using an orienteering compass and a topographic map, follow the instructions below to learn more about orienteering.

First, find the spot on the map corresponding to where you are standing. Next, find another spot corresponding to where you want to go. Place one edge of the compass along your desired line of travel on the map. Figure out the distance between where you are and where you want to go, using the map scale. Determine how many paces it will take you to reach this point. For example, if your individual pace measurement is 20 paces per 100 feet and you want to go 200 feet, you will have to count 40 paces to reach the marker. **Without removing the compass from the map**, turn the compass housing until the orienteering arrow points to north on the map. You've now set the compass for your line of travel.

Holding the compass in your hand, turn it horizontally until the magnetic needle is "framed" by the orienting arrow. The direction-of-travel arrow will point to your desired route. The degree reading is your bearing (direction). Walk in that direction, counting the number of paces you figured you were from your spot. You should end up at the destination you chose on the map!

LET'S GO ORIENTEERING

The more you practice using a compass, the more accurate you will become. Here is a fun exercise that will help you sharpen your orienteering skills.



Find a spot where there are no fences, trees, or other obstacles for 50 feet. Put a stake in the ground to mark your position.

1. Figure the number of your paces it will take to go 50 feet. (See "Pacing Yourself" on page 39.)
2. Set any bearing you wish on your compass, for example 45° (45 degrees).
3. Stand next to your stake and pace 50 feet in the direction of your compass bearing. Be accurate, both in pacing and following the bearing.
4. After 50 feet, stop. Add 90 degrees to the compass bearing, then pace 50 feet in that new direction.
5. Complete the sides of the square by adding 90 degrees each time you have paced 50 feet.
6. If you have been completely accurate, you will have returned to your starting point. How far are you from that point?

When you have successfully completed a 50-foot square, complete a square with 100-foot sides. How far are you from your starting point on this square?

COMPASS POINTS TO REMEMBER

A compass alone can keep you on a path, but you need a map to know where you want to go. A compass isn't much help without a map.

Decide from a map which direction you want to go.

Find the approximate direction (bearing) in degrees.

Use your compass (as described above) or a protractor to figure the exact bearing. This will help prevent a 180-degree error.

CAREER CONSIDERATIONS

A **forest engineer** designs and constructs roads for timber sales and access. The engineer first surveys the area, using orienteering skills, to determine where a road could be constructed. The forest engineer bases the road layout upon factors such as bluffs, steep hillsides, and stream crossings. The forest engineer then does a formal survey and stakes the locations for the new road. A forest engineer always seeks to minimize erosion and damage to the forest.

If you want to be a forest engineer, a good place to start is with a four-year forest engineering degree from a college or university.

QUIZ FOR THE REAL WHIZZES

Fill in the blanks below using the words at the end. Whiz through this!

1. The length of your stride measured in feet is your _____.
2. A _____ map illustrates changes in elevation or contours.
3. _____ is the art of using a map and compass to find your way.
4. The _____ explains what map symbols represent on the ground.
5. Wandering lines on a topographic map that show elevation are called_____ _____ .
6. _____ is the direction traveled.
7. A _____ map shows detail in flat perspective.
8. _____ is the science of locating points or lines on the surface of the earth.
9. The _____ tells how many units on the ground are represented by each unit of measurement on a map.

planimetric	**map scale**
map legend	**contour lines**
bearing	**surveying**
topographic	**pace**
orienteering	

LEAVE THE ANSWER TO ME

The sun rises in the east and sets in the west, and the North Star is part of the Little Dipper's tail. What other clues would you use to find north, south, east, and west without a compass?

TREE-VIAL PURSUIT

People have used compasses for more than a thousand years. Before compasses were invented, only navigators who could tell directions from the movement of the stars and sun could attempt ocean voyages. If they died during a voyage, their ships often were lost at sea!

YEARNING TO LEARN

Additional Activities

In the following activities, remember the basic rules of conservation. Do not damage or destroy the plants and animals you are studying. Leave all animal homes unchanged. Have a positive impact on the forest.

Build a Christmas tree! You will need a compass, pencil, and graph paper. Assume that your piece of graph paper is a map. Place a dot in the center of the paper. This dot is the start of your map. Using the bearings and distances given on page 43, move from one point to the next. Place dots at each point you locate. Connect the dots to finish the Christmas tree.

Construct your own figures using bearings, distances, and graph paper. Try a square or a triangle, at first. After you become more skilled, construct a star, a maple leaf, or even an animal. Give the bearings and distances to your friends, and see if they can reconstruct the drawing you have invented.

Make a planimetric map of your backyard or nearby lot on graph paper using your compass and pacing. Use a scale of 1 inch equals 20 feet. Indicate the starting point on your map, and then trace the yard or lot boundaries. Record distances (by pace) and the bearings you followed to map the boundaries.

EXHIBITS AND FAIR PROJECTS

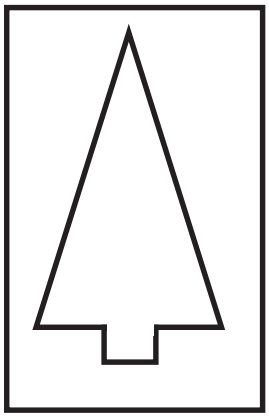
Make a planimetric map of a forest, park, or neighborhood. Determine your bearings using your compass, and find distances using your pace. Include the approximate locations of buildings, large trees, roads, sidewalks, pathways, and fences. Draw the map to a consistent scale. Make sure you include bearings and distances of boundaries. Add a title, legend, scale, and north arrow. Some suggestions to help you complete this project:

1. Take accurate notes while using the compass and pacing. For example:

Point	Bearing	Distance	Notes
1 to 2	53°	130'	Crossed stream at 96' from point 1.
2 to 3	86°	75'	Followed fence line for 75'

2. Use a protractor and ruler to transfer distances and bearings from notes to your map.
3. Make a rough copy that includes features such as buildings and streams; then transfer them to the final map.

BUILD A CHRISTMAS TREE!



Bearing	Distance (inches)
270°	0.5
360°	1.0
270°	2.0
31°	5.0
149°	5.0
270°	2.0
180°	1.0
270°	0.5

ANSWERS

Contour Lines Quiz

A = 4
B = 2
C = 1
D = 3

Quadrant Quiz

232° = SW
7° = NE
316° = NW
90° = Due east
107° = SE
0° = Due north

Quiz for the Real Whizzes

1. pace
2. topographic
3. orienteering
4. map legend
5. contour lines
6. bearing
7. planimetric
8. surveying
9. map scale

Chapter 6

MEASURING THE FOREST
Forest Inventory Basics

TAKING AN INVENTORY

Standing in a mature stand of white oak, two forest technicians silently inventory the forest. The technicians watch as a red-tailed hawk soars overhead and follow the bird until it is only a dot in the sky. They notice a few lady-slippers growing on the forest floor and record that fact on their inventory sheet. Using special instruments, the technicians measure and record information about the trees around them.

Along with the timber measurements, the hawk's passage and the ladyslippers will be useful information to others. The data they gather will help natural resource managers make wise decisions about management for the white oak stand.

A forest inventory provides land managers with information about:

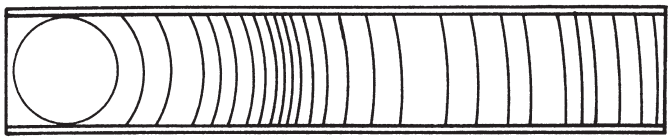
- **forest type**
- **approximate age and size class of timber**
- **disease or insect pests**
- **timber volume**
- **stand density**
- **tree reproduction (regeneration)**
- **site productivity (ex: site index)**
- **topography**
- **noteworthy features, unique plants, or wildlife**

READING THE RINGS

Foresters and forest technicians use a tool called an increment borer to determine a tree's age. The borer is pressed against a standing tree at 4 1/2 feet above the ground and turned until it drills through to the center of the tree. This action forces a sample of wood, called a ring core sample, into the borer. The forester or technician then removes the sample, counts the annual rings, and records the age.

Foresters can get a lot of useful information from a ring core sample. It can help them determine how old all the trees in the stand are and how close they are to the rotation age. The rotation age is the optimum age for harvest. By looking at the width of recent annual rings, a forester can also determine if the tree is growing under satisfactory conditions.

How old do you think this tree is?



UNITS OF MEASUREMENT

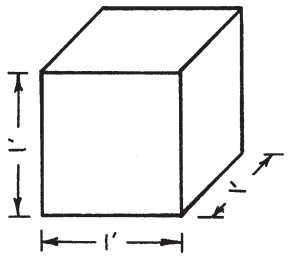
Wood volume is one of the most common bits of information provided by a forest inventory. It is measured in order to obtain a fair selling price when marketing timber.

In the United States, we use three different units to measure wood volume: cubic feet, board feet, and cords. Most of the rest of the world uses cubic meters. It is also becoming more common to measure wood, especially pulpwood, by weight (usually in tons) rather than by volume.

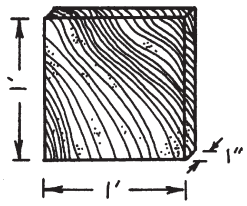
A **cubic foot** measures 1 foot by 1 foot by 1 foot. It equals 1,728 cubic inches. This measure is usually used to describe the total amount of wood in a forest stand and for pulpwood. Pulpwood is used to make paper and paper products.

A **board foot** is the volume of a board that is 12 inches wide, 12 inches long, and 1 inch thick. It equals 144 cubic inches. Board feet are used when lumber or veneer (a thin layer of wood that is peeled or sliced from logs) is the most likely product.

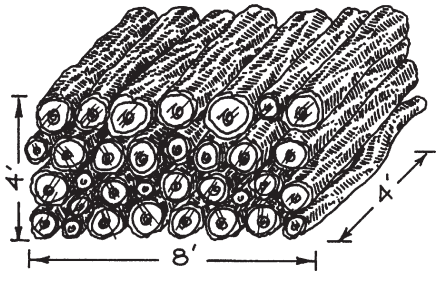
A **standard cord** is a stack of wood that contains 128 cubic feet of wood, bark, and air. A standard cord usually contains 79 cubic feet of actual wood. The common dimensions of a cord are: 8 feet long, 4 feet wide, and 4 feet high. The weight of a standard cord or any volume of wood varies depending on the species and the moisture content of the wood. The standard cord is used to measure pulpwood and fuelwood (wood for heating/energy).



Cubic Foot



Board Foot



Cord

SIZING THINGS UP

To determine a tree's volume, you first need to measure its diameter and merchantable tree height.

Tree diameter is measured at breast height, which is defined as 4.5 feet above the ground on the uphill side of the tree. We abbreviate the term "diameter at breast height" as dbh, usually written without capital letters and without periods.

Merchantable tree height is the usable portion of the tree. It is the distance between the presumed stump height and the point where the trunk becomes unusable.

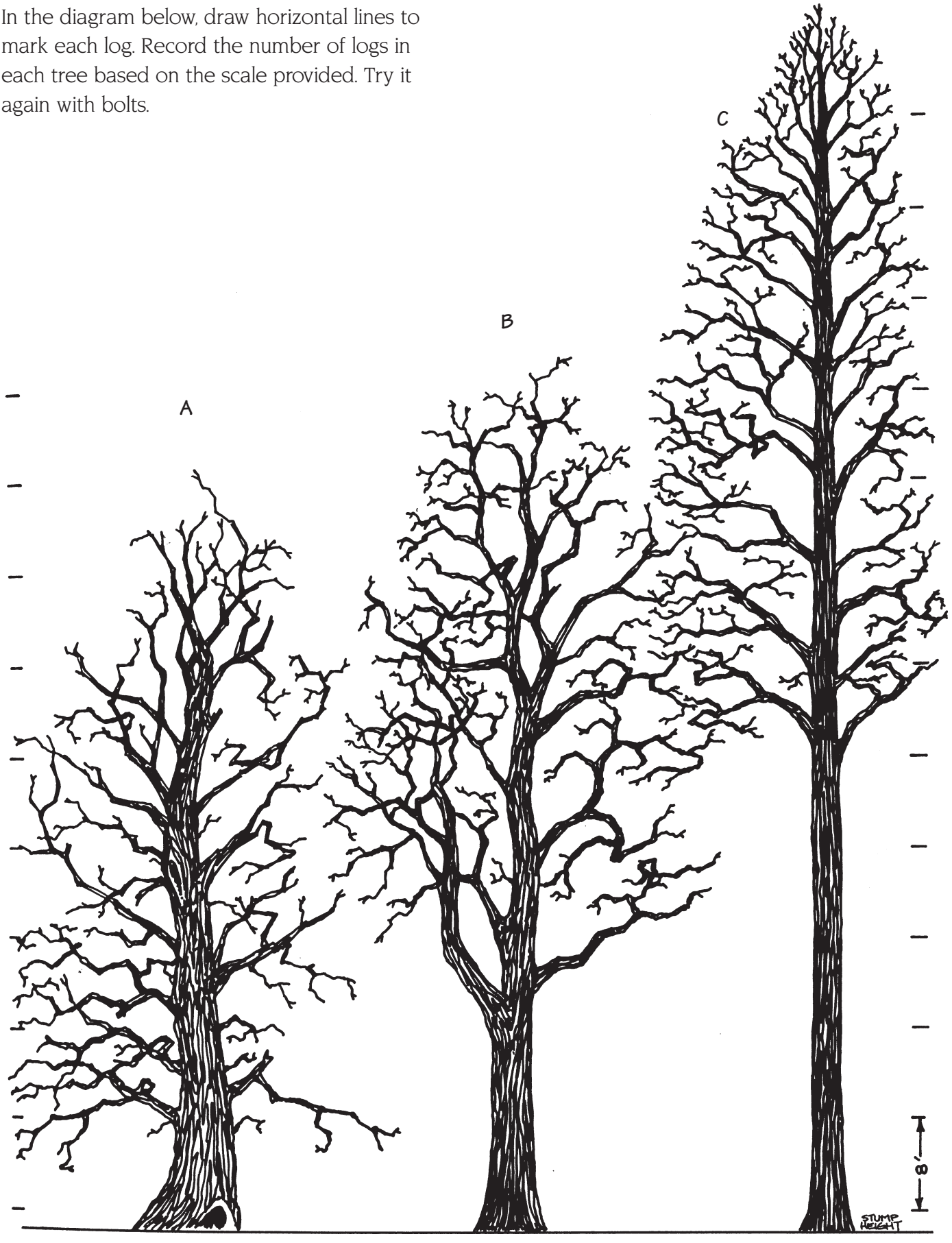
For hardwoods (deciduous trees), this is a measure 1 foot above the ground and for softwoods (coniferous, or evergreen, trees) from 6 inches above the ground.

Merchantable height ends where the trunk tapers to a diameter of 4 inches for pulpwood or 8 inches for sawtimber (logs used for lumber) or where a large fork, rot, or another defect limits its use.

In Pennsylvania, as in most of the northeastern United States, we estimate merchantable height in 16-foot lengths called logs. For example, a tree with 48 feet of merchantable sawtimber height has 3 logs in it. A tree with 24 feet of merchantable material has 1 1/2 logs in it.

Another method of measuring merchantable height is in 8-foot lengths called bolts or sticks. There are 2 bolts in 1 log.

In the diagram below, draw horizontal lines to mark each log. Record the number of logs in each tree based on the scale provided. Try it again with bolts.



TOOLS OF THE TRADE

Instruments used to measure diameter are the diameter tape (D-tape) and Biltmore stick. The Biltmore stick also is used to measure tree height. You can make a set of these measuring tools for yourself.

MAKING AND USING A D-TAPE

You will need:

- a cloth measuring tape, available at fabric stores
- a black permanent marker

Starting from 0, mark a line on the tape every 3.14 (about 3 1/8) inches. Number the first line "1", the next "2", and so on. Each line corresponds to one inch in diameter when the tape is wrapped around a tree.

After you complete the tape, take it outside and practice measuring the diameter of some trees in your yard or neighborhood. Wrap the tape around a tree 4 1/2 feet above the ground. Be sure to hold the tape horizontally all around the tree. Read the tree's diameter on the tape where the tape crosses the end.

MAKING AND USING A BILTMORE STICK

You will need:

- two paper ruler strips labeled "For Standing Trees" (see outside back cover)
- a yardstick or piece of wood lath
- tape or glue

Cut out or copy the two paper ruler strips. Staple or tape them together end-to-end to make one long strip. Then tape or glue the long strip to the lath or yardstick.

To measure tree diameter, hold your Biltmore stick 25 inches from your eye. Press the stick horizontally against a tree trunk, 4 1/2 feet above the ground. Move the stick so the left end lines up with the left edge of the tree.

Without moving your head, look at the right edge of the tree and read the number on the Biltmore stick closest to where your line of sight crosses the stick. Be sure to use the "diameter of tree (inches)" scale. This number is the tree diameter in inches.

To measure height with a Biltmore stick, stand 66 or 100 feet (depending upon the type of stick) from the tree you want to measure. (Measure this distance with a tape or pace it off.) Hold the Biltmore stick vertically 25 inches from your eye. Move the stick so the bottom end lines up with the tree's (likely) stump height.

Without moving your head, look up the tree and find the point where the tree trunk reaches the minimum acceptable diameter for the product you are measuring (4 inches for pulpwood, 8 inches for timber) or where defects limit its use.

Read the number on the "height" scale closest to the spot where your line of sight crosses the stick. This is the tree height.

DETERMINING TREE VOLUME

Once you have measured a tree's height and diameter, you can find the volume of usable wood in that tree. Foresters generally use volume tables to determine the amount of wood per tree. At the end of this unit, you'll find a table for estimating board foot volume.

Let's use white oak as an example:

The measurements are:

dbh: 16 inches

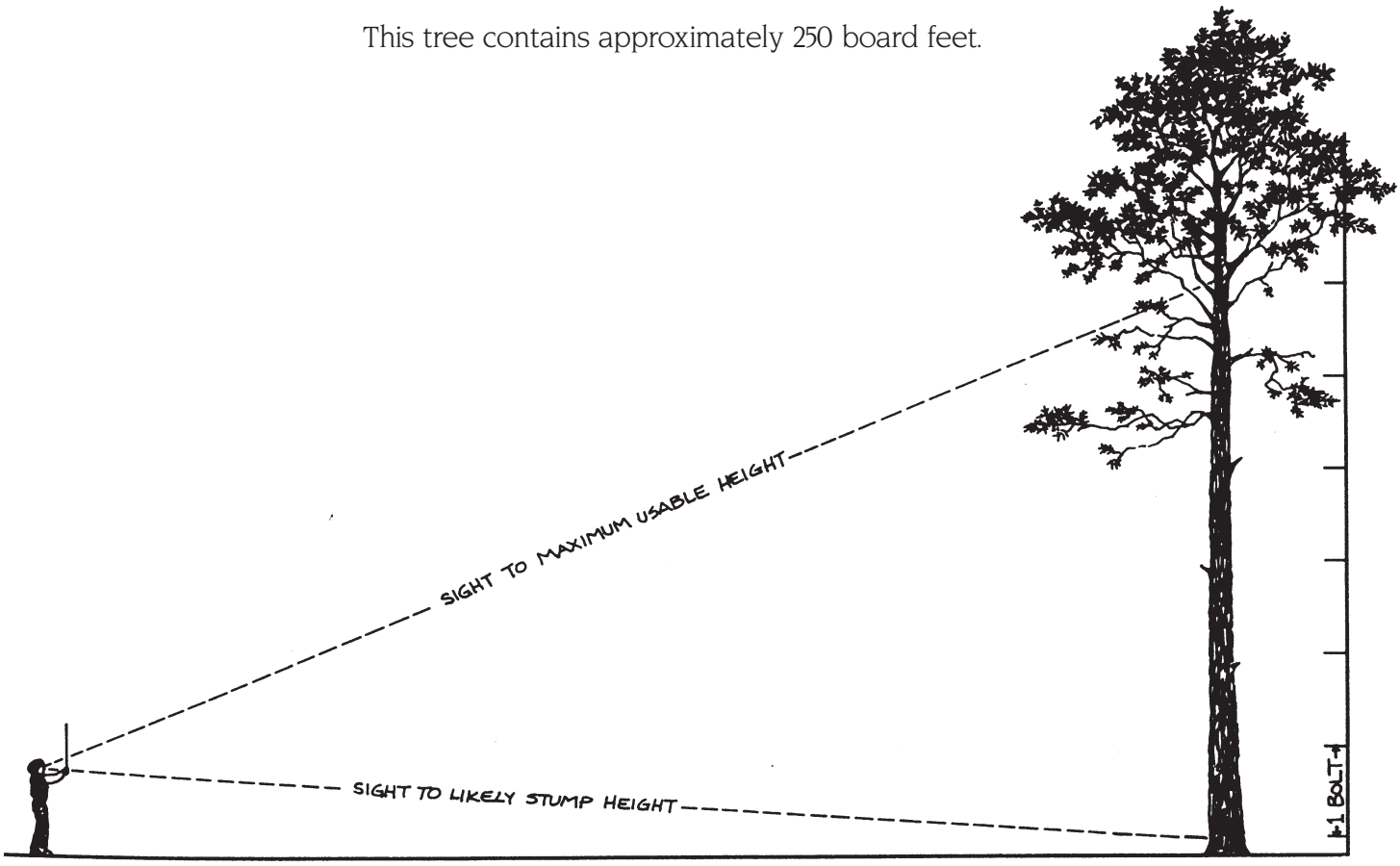
Height (merchantable): 48 feet

Total number of 16-foot logs: (48 ÷ 16) = 3

Total board feet:
(bd ft taken from table on page 52)

250 board feet

This tree contains approximately 250 board feet.



QUIZ FOR THE REAL WHIZZES

Fill in the blanks below using the words at the end. Whiz through this!

1. _____ is the abbreviation for diameter at breast height.
2. A _____ measures 1 foot by 1 foot by 1 foot.
3. A _____ is a 16-foot length of a tree.
4. A measurement of certain characteristics of a forest, including timber volume and tree growth rate, is a _____ _____.
5. A _____ contains 128 cubic feet of wood, bark, and air.
6. Cubic feet, weight, or cords are used to measure _____.
7. A _____ measures 12 inches by 12 inches by 1 inch.
8. _____ is the usable length of the tree.

board foot	pulpwood
cord	merchantable height
dbh	bolt
cubic foot	forest inventory
log	

CAREER CONSIDERATIONS

A **forest technician** inventories forests for federal, state, county, and private groups. You have to really like the outdoors to be a forest technician. You will spend a lot of time in the forest measuring tree volumes, growth rate, tree age, and site productivity. To be a forest technician, you will need at least a two-year technical degree from a college or vocational technical institute.

LEAVE THE ANSWER TO ME

Why do we make a D-tape by placing an inch mark every 3.14 inches along the tape?

TREE-VIAL PURSUIT

People in the United States use enough firewood each year to build a 100-foot tall wall of wood from New York City to San Francisco.

YEARNING TO LEARN

Additional Activities

In the following activities, remember the basic rules of conservation. Do not damage or destroy the plants and animals you are studying. Leave all animal homes unchanged. Have a positive impact on the forest.

Measure the diameter of several trees using both the Biltmore stick and the D-tape you constructed earlier. Record these measurements for at least six trees.

Do the measurements from the two instruments agree? How close are they?

Measure the height and diameter of at least six trees in your neighborhood, local park, or woods. Trees should be at least 10 inches in diameter and 8 feet in merchantable height. Record each tree's species, dbh, merchantable height in feet, and number of logs in a table like the one below. Using the table on page 52, estimate the tree volumes. This will tell you how many board feet are in each tree you record in your chart.

EXHIBITS AND FAIR PROJECTS

Estimate the timber volume per acre in a nearby woodland as follows:

1. Make a circular plot of 0.1 acres by putting a stake into the ground in the center of the plot and measuring out 37.2 feet (37 feet, 2 1/2 inches) from the stake in all directions.
2. Measure all trees greater than or equal to 12 inches in diameter in this plot.
3. Record your measurements and volumes on a table like the one below.
4. Repeat steps 1 through 3 for four other plots in the woodland.
5. Average the volume for each species over all the plots and multiply the average volume for each species by 10 to get the volume per acre. (Remember, your plots are 0.1 acres in size.) Include a copy of your tables, photos of the area, and photos of you taking measurements. If available, include the size of the woodland in acres.

ANSWERS

Ring Count Exercise:

27 rings

Log/bolt exercise

Tree	A	B	C
Logs	1	1	4
Bolts	2 1/2	2 1/2	8 1/2

Quiz for the Real Whizzes

1. dbh
2. cubic foot
3. log
4. forest inventory
5. cord
6. pulpwood
7. board foot
8. merchantable height

Species	*dbh (inches)*	*Merch. height*	*16' logs*	*Volume (board feet)*

TREE VOLUME IN BOARD FEET (1/4 inch international)

DBH	Number of 16-foot logs							
(inches)	1/2	1	1-1/2	2	2-1/2	3	3-1/2	4
	Contents in board feet							
12	30	60	80	100	120			
14	40	80	110	140	160	180		
16	60	100	150	180	210	250	280	310
18	70	140	190	240	280	320	360	400
20	90	170	240	300	350	400	450	500
22	110	210	290	360	430	490	560	610
24	130	250	350	430	510	590	660	740
26	160	300	410	510	600	700	790	880
28	190	350	480	600	700	810	920	1020
30	220	410	550	690	810	930	1060	1180
32	260	470	640	790	940	1080	1220	1360
34	290	530	730	900	1060	1220	1380	1540
36	330	600	820	1010	1200	1380	1560	1740
38	370	670	910	1130	1340	1540	1740	1940
40	420	740	1010	1250	1480	1700	1920	2160
42	460	820	1100	1360	1610	1870	2120	2360

4-H ACTIVITIES REPORT

This report will help you keep a better record of your club activities. Fill it in as you complete each assignment. Refer to this record when you are entering county, state, and national programs. Ask your local leader to explain these programs to you.

My 4-H Activities Report for the 19 ———— Club Year

Projects taken _____

_____

_____

_____

Offices held _____

_____

Club _____

County _____

"Show-and-tells" given to

Family _____

Friends _____

Local club _____

County _____

Regional _____

State _____

News articles _____

Radio _____

TV _____

Things done to improve my health _____

_____

_____

Community service or citizenship work done

By myself _____

With club _____

Number of meetings my club(s) held this year _____

Number I attended _____

Number of new members I encouraged to join 4-H ____

Number of boys and girls I helped with projects _____

In what way? _____

_____

_____

Check those attended and tell how you helped

_____ 3- or 4-day camp

_____ 1-day camp

_____ Club or county tours

_____ Club picnic

_____ Countywide picnic

_____ 4-H Sunday

_____ County fair

_____ Achievement programs

_____ Roundup

_____ Teen Leader Retreat

_____ State 4-H Capital Days

_____ Camp Leadership Training

_____ Penn State 4-H Achievement Days

_____ Pennsylvania Farm Show

_____ National 4-H Week

_____ State Ambassador Conference

_____ Judging training

Others:

_____

_____

_____

PENNSTATE

College of Agricultural Sciences
Cooperative Extension

Name ______________________________

Address ______________________________

____

Name of club ______________________________

Leader's name ______________________________

4-H Club Motto
"To make the best better"

4-H Club Pledge
I pledge
my head to clearer thinking,
my heart to greater loyalty,
my hands to larger service, and
my health to better living, for
my club,
my community,
my country, and
my world.

4-H Club Colors
Green and White

18 U.S.C. 707

FOR STANDING TREES

Diameter of tree (inches)

Height (No. Foot Logs)

To Read Diameters: Hold Stick 25 Inches From Eye Against
Tree At Height of 4 1/2 Feet.

To Read Heights: Stand 100 Feet From Tree and Hold Stick
Hold Stick Vertical 25 Inches From Eye.